

**INTERFACE CONTROL DOCUMENT
FOR THE
STU-III BLACK DIGITAL INTERFACE**

Prepared For:

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NOTICE

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NOTICE

communicating with STU-III BDI terminals connected to the digital cellular system, MSAT system, or other narrowband digital systems with an ISDN interface.

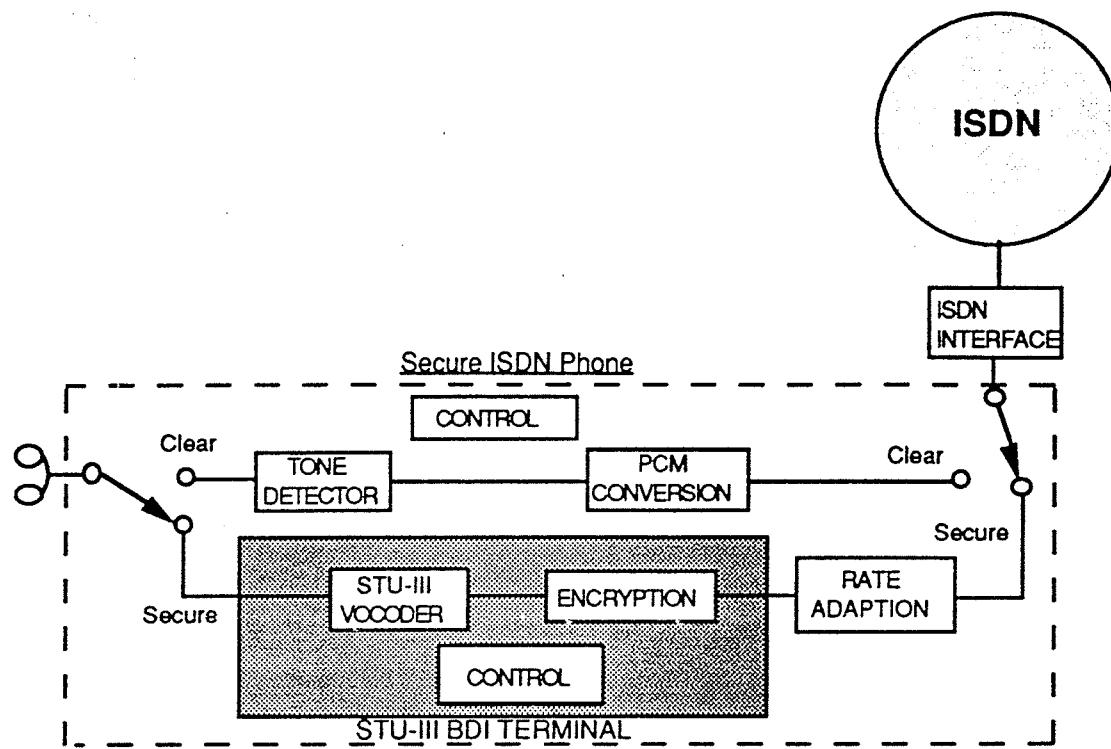


Figure 6.6-2 STU-III BDI Connected to ISDN

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0111 0000 0011" (the STU-III BDI short preamble). This is followed by the EQU block (160 bits) containing the PN dabit sequence:

1122 1013 2010 2013 1323 2310 2320 2313 1010 1320
1020 1313 2323 1023 2023 1310 1013 2010 2013 1323.

ED	DIB	SP	EQU	
538 bits	326 bits	272 bits	160 bits	-----

Figure 6.5-1 UHF/Satellite Radio Preamble

When the long preamble shown in Figure 6.5-1 is used, it shall replace the short (272-bit) preamble specified previously in the STU-III BDI message transmission format.

6.6 Narrowband Digital to ISDN Network Connections

The interoperability of STU-III BDI terminals on various digital networks depends largely on the design of the telephone network interface for these systems. A diagram of the interconnection between ISDN and Digital Cellular is shown in Figure 6.6-1. (A similar configuration would also be used for connecting MSAT to ISDN.)

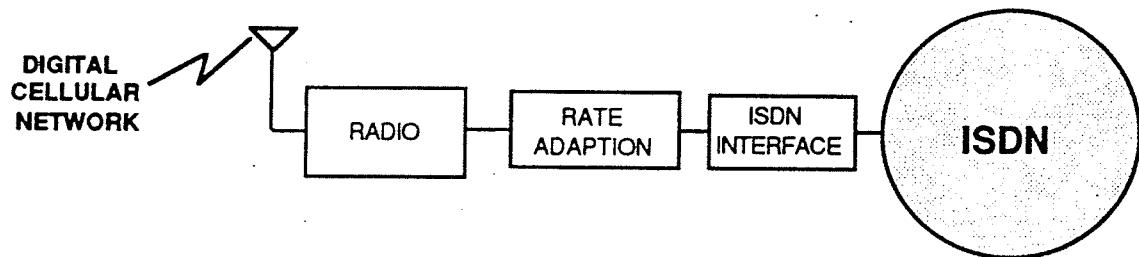


Figure 6.6-1 Digital Cellular to ISDN Interface

A STU-III BDI terminal may also be used for communications over ISDN. However, since ISDN provides 64 kbps connections, a rate adapter is necessary to convert the STU-III BDI output to 64 kbps. This implementation, shown in Figure 6.6-2, could then be used for

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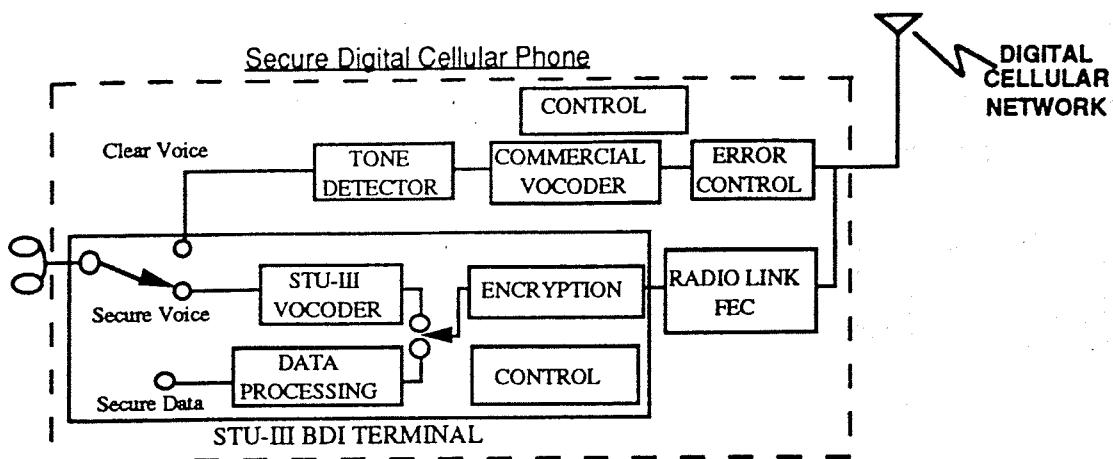


Figure 6.3-1 STU-III BDI on the Digital Cellular Network

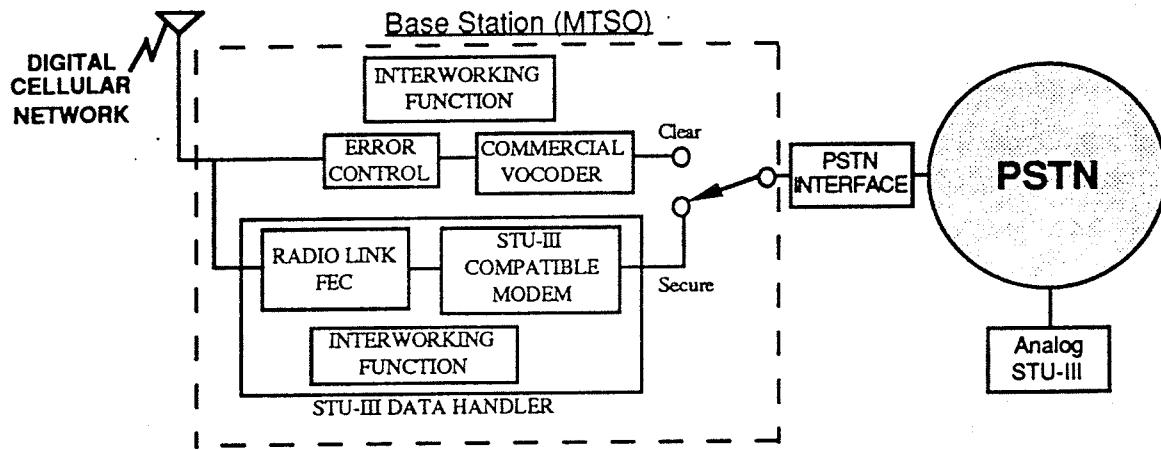


Figure 6.3-2 PSTN to Digital Cellular

6.5 Considerations for Other Radio Systems (OC)

For some UHF/satellite radio systems, a different (longer) preamble, shown in Figure 6.5-1, may be required. Previous implementations of the STU-III/MPT required a similar preamble to achieve satisfactory operation over certain radio links. In this preamble, the ED block contains 268 bits of zeroes, followed by 270 bits (135 copies) of the binary pattern "01". The DIB block contains 326 bits composed of 81 copies of the binary pattern "0010" followed by the binary pattern "00" (one copy). The SP block contains 272 bits (17 copies) of the binary pattern "0101

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6.2.2 Private Digital Networks

Figure 6.2.2-1 illustrates a private digital network with digital switches at each end. Terminal addressing is accomplished by methods and equipment external to the STU-III BDI terminals.

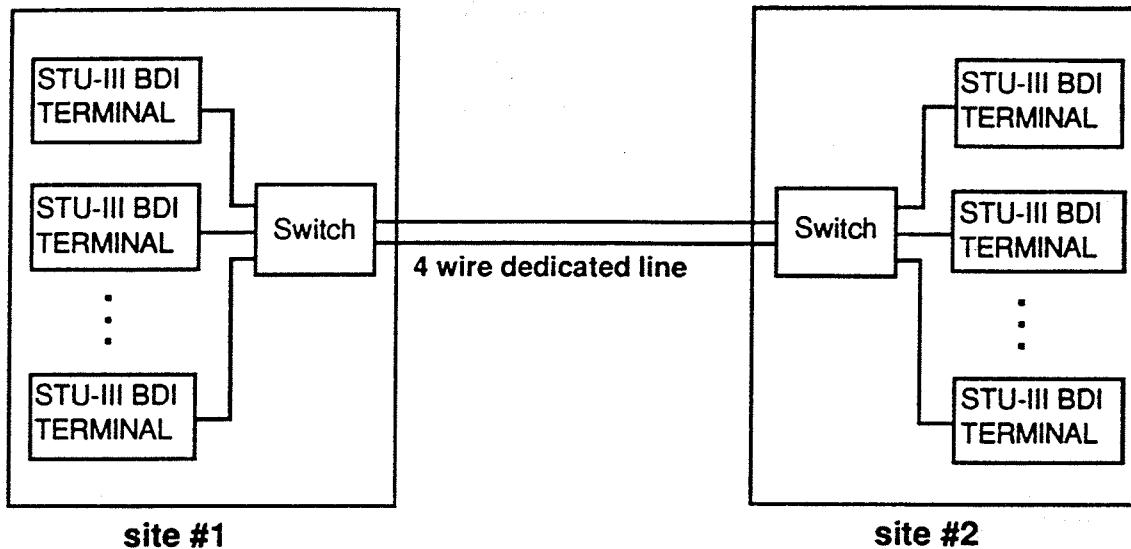


Figure 6.2.2-1 Site to Site Dedicated Link

6.3 Digital Cellular

The Digital Cellular implementation of a STU-III BDI is similar to an analog cellular STU-III, except the modem is removed and located at the base station. Figures 6.3-1 and 6.3-2 illustrate the STU-III compatible mobile configuration. The STU-III BDI to digital cellular interface is the point of connection of the digital cellular vocoder and the radio transmission equipment. Note that STU-III BDI output must be extended by error control, bit stuffing, etc., to match the digital cellular system data rate.

6.4 Mobile Satellite

An MSAT STU-III BDI terminal is essentially the same as a digital cellular STU-III BDI terminal, except the transmission is to a satellite that transmits to the ground station, which is connected to other networks such as PSTN or ISDN.

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6 APPLICATION DESCRIPTIONS

6.1 Network Configurations Using the STU-III BDI

Currently, three configurations in which a STU-III BDI would be applicable have been identified. These are dedicated links (e.g., HF radio links), digital to analog connections such as digital cellular or MSAT to the Public Switched Telephone Network (PSTN), and digital to digital connections such as digital cellular or MSAT to ISDN. Note that the STU-III BDI will require external rate adaption to connect to ISDN, the description of which is beyond the scope of this specification. Also, digital to analog connections will require a STU-III compatible interworking function as defined in Section 5.0 at the digital to analog system interface.

6.2 Dedicated Digital Communication Links

6.2.1 HF Modem Links

A high frequency radio link is an example of a dedicated link to which the STU-III BDI may be connected. Figure 6.2.1-1 illustrates a typical application of an HF modem link. The shipboard STU-III BDI terminal communicates with STU-III BDI terminals at the shore station. The high frequency radio link is first established, and the STU-III BDI operates over the dedicated connection.

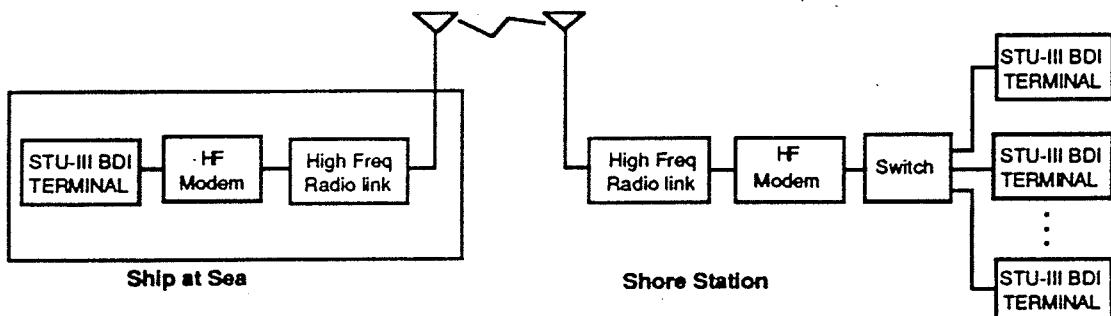


Figure 6.2.1-1 Ship to Shore Radio Link Connecting STU-III BDI Terminals

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5.1.2 Clear Vocoder Function (OC)

While the PSTN allows the STU-III to use analog signals to exchange clear mode audio, a narrowband digital channel requires a vocoder for clear voice. The vocoder function takes a voice signal and produces a stream of digital data that is sent across the digital channel; conversely, it takes a stream of digital data and produces an audible voice signal. Although this function may be an integral part of a host system, some digital networks have separate voice and data services, thereby requiring a new call if users wish to transition between clear and secure voice modes.

A clear mode vocoder is a STU-III BDI terminal Optional Capability. If the STU-III BDI terminal provides this capability, users can easily transition between clear and secure voice modes. This is specified as an essential part of the optional STU-III BDI clear mode in Section 4.3.5.4. A supporting IWF shall follow those requirements on the digital side. The IWF converts the STU-III BDI digital voice bit stream into a standard analog side audio signal to be sent to the STU-III. Clear voice from the analog side is converted into a STU-III BDI digital vocoder bit stream using the vocoder standard appropriate for the signaling rate.

5.1.3 Modem Function

The modem function uses digital data received by the Interworking Function to modulate the carrier on the analog line. This data consists of control messages, data fields of data messages, or other messages required by FSVS-210. The Interworking Function turns the modem function on and off as required.

The modem function also demodulates the analog line signal and delivers a stream of digital data for transmission over the digital link by the Interworking Function. The IWF monitors the stream for call setup and call-interruption messages, and formats portions of the stream into messages for the black digital interface.

If the modem function should detect a Telco fade (i.e., if modem carrier is lost for five seconds or more) a PSTN Fade Timeout will be declared, and the IWF will lead the STU-III BDI in a Go Clear/Clear ACK exchange.

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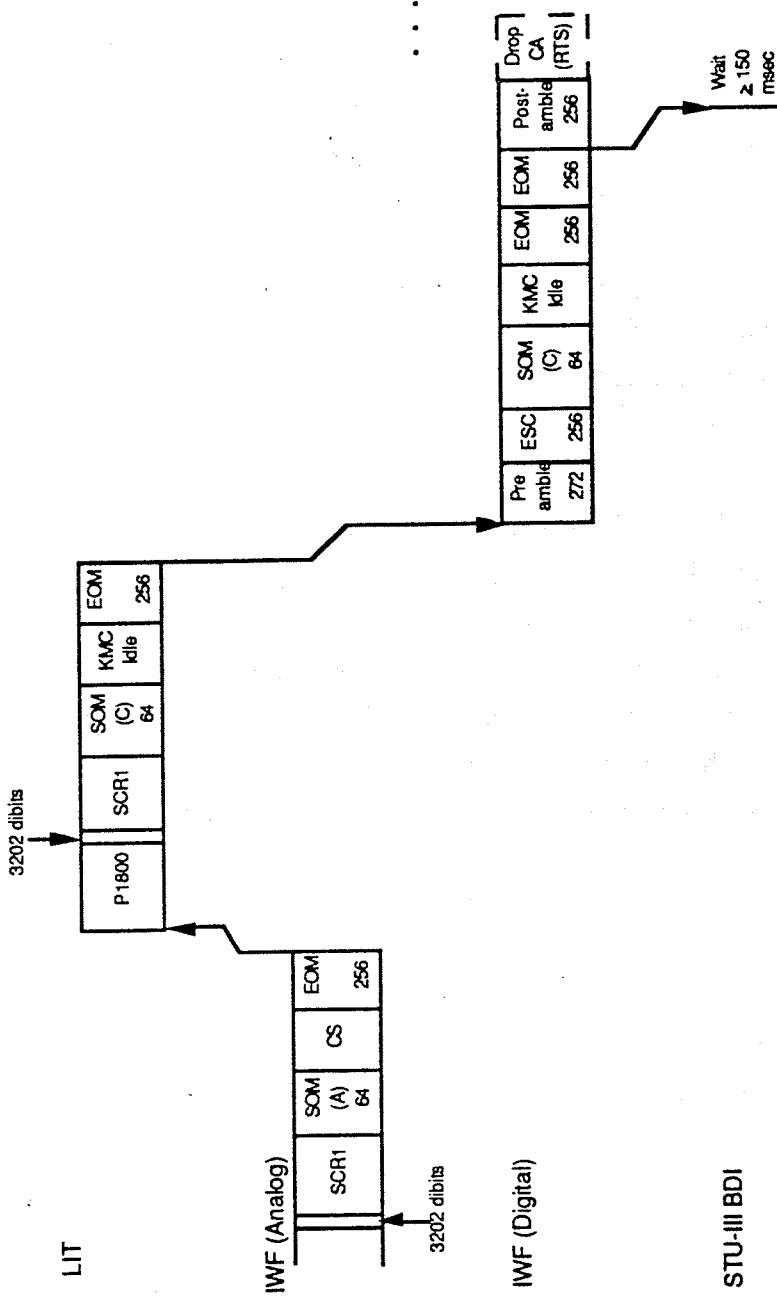


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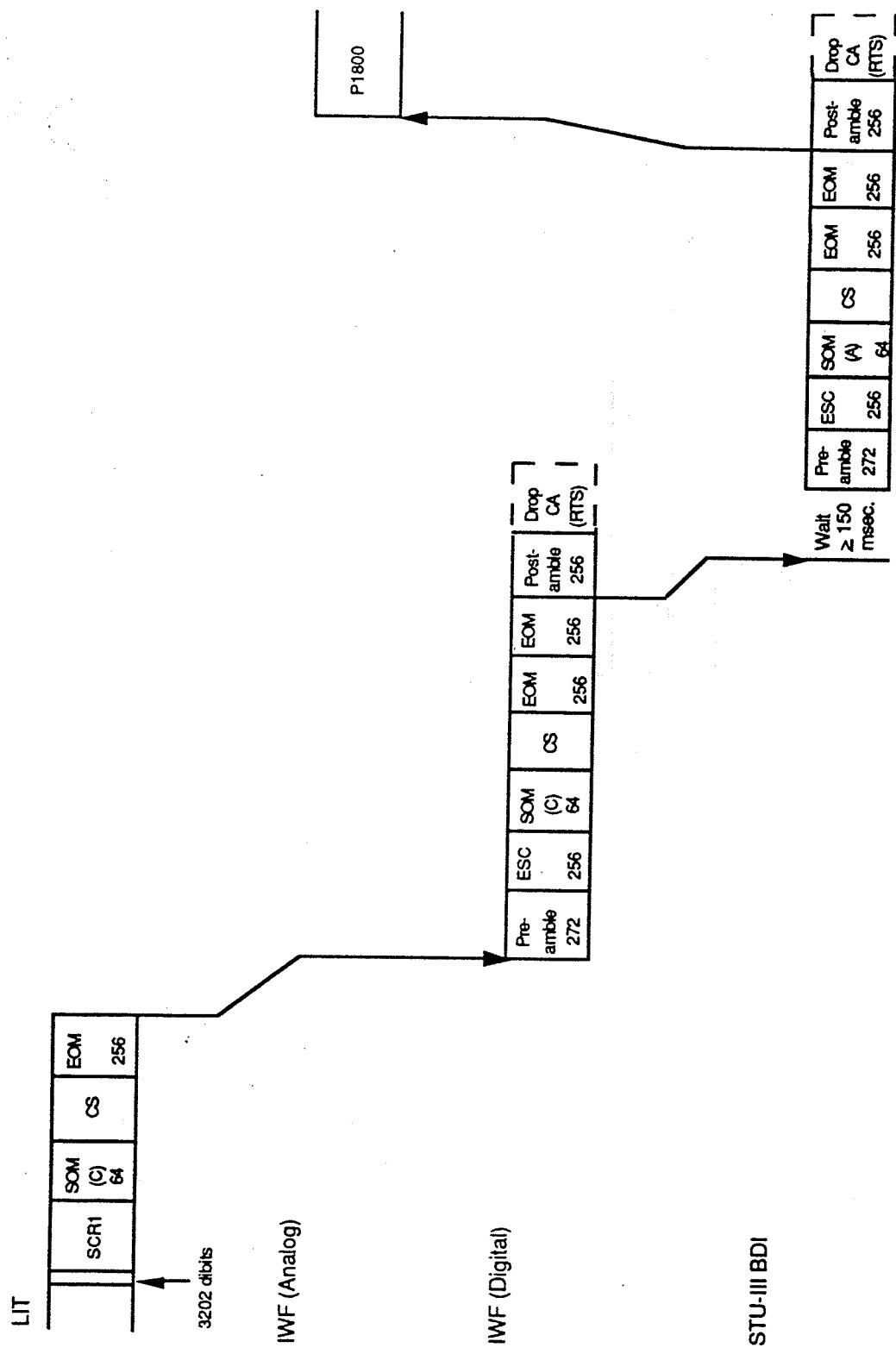


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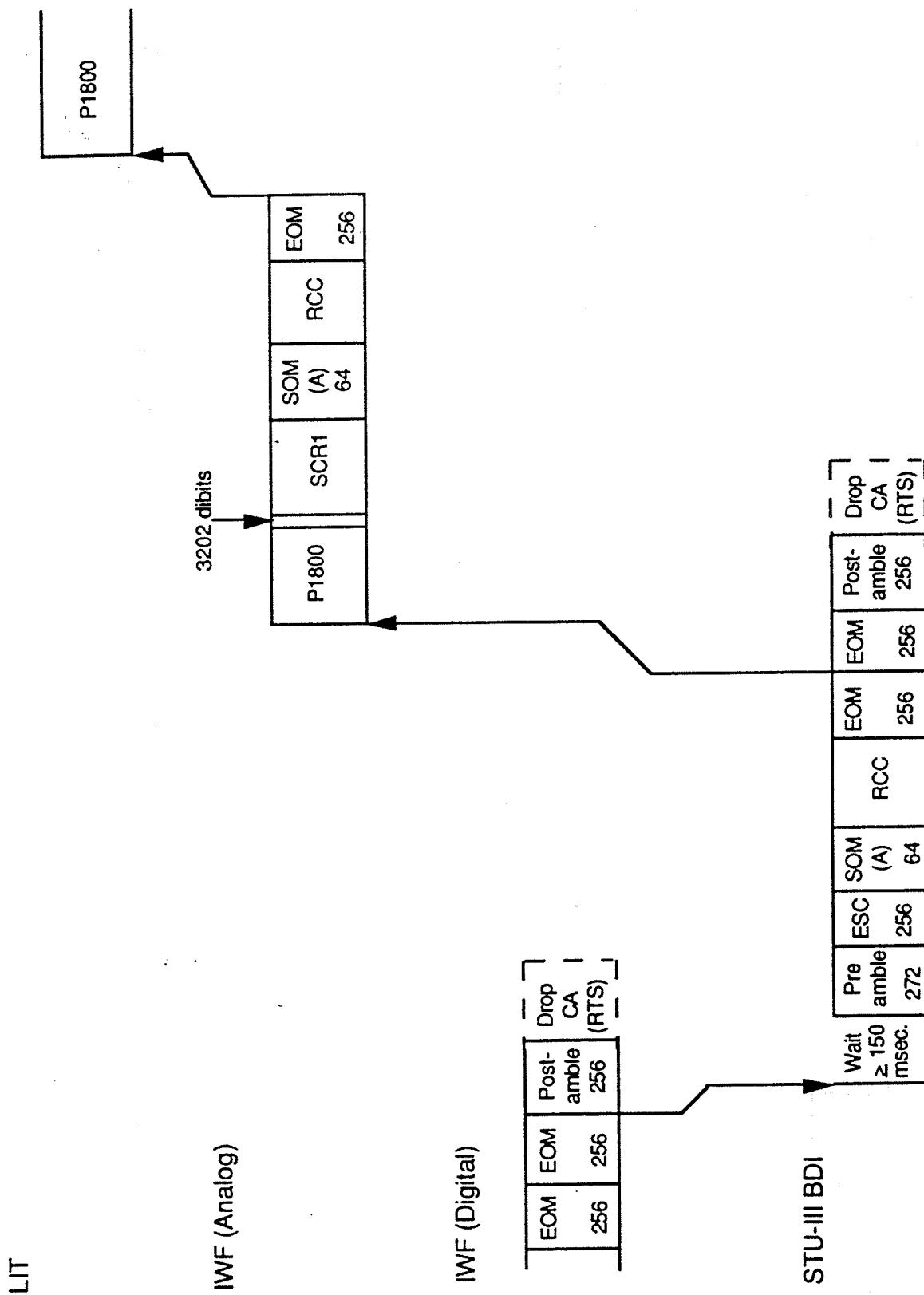


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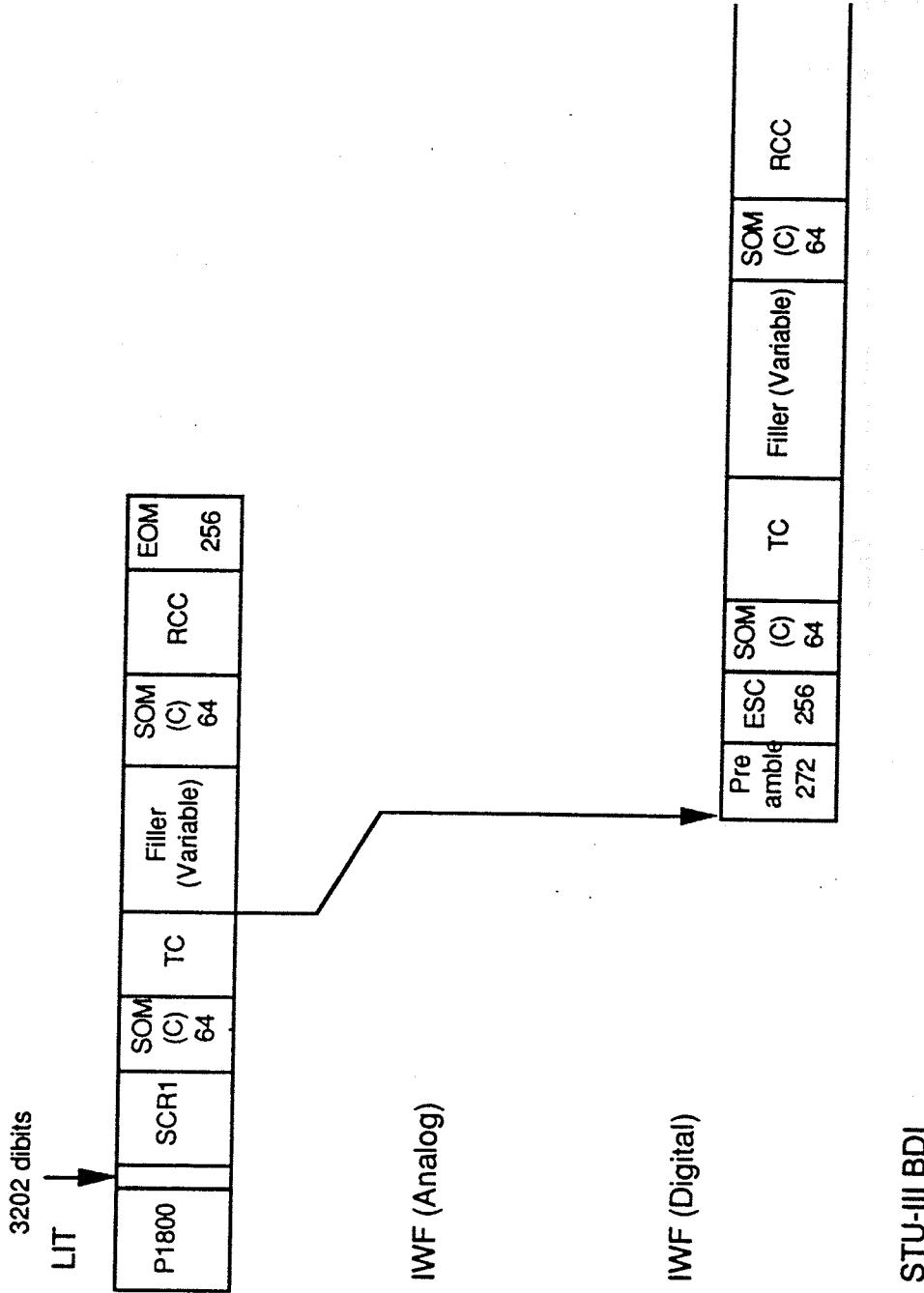


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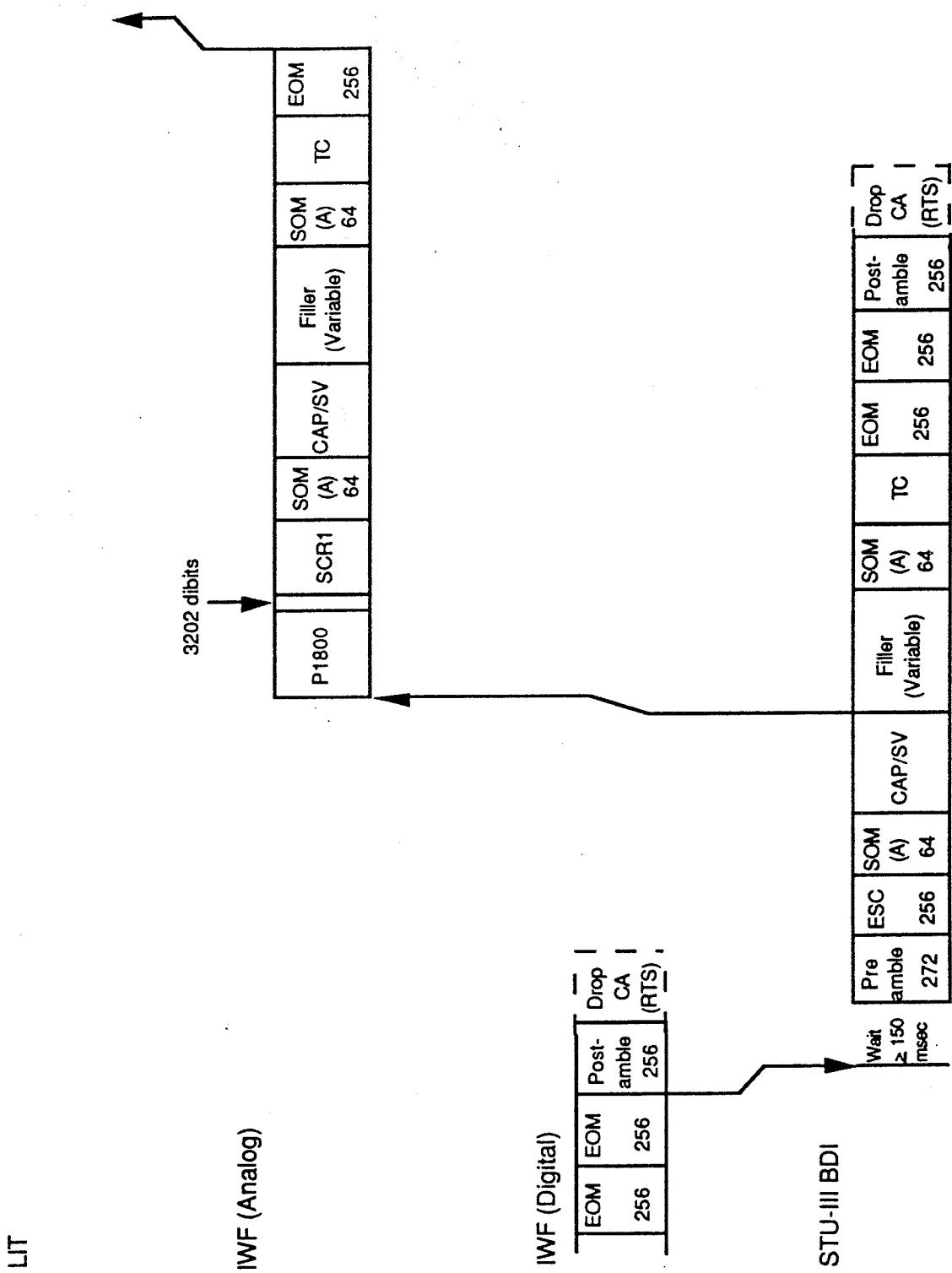


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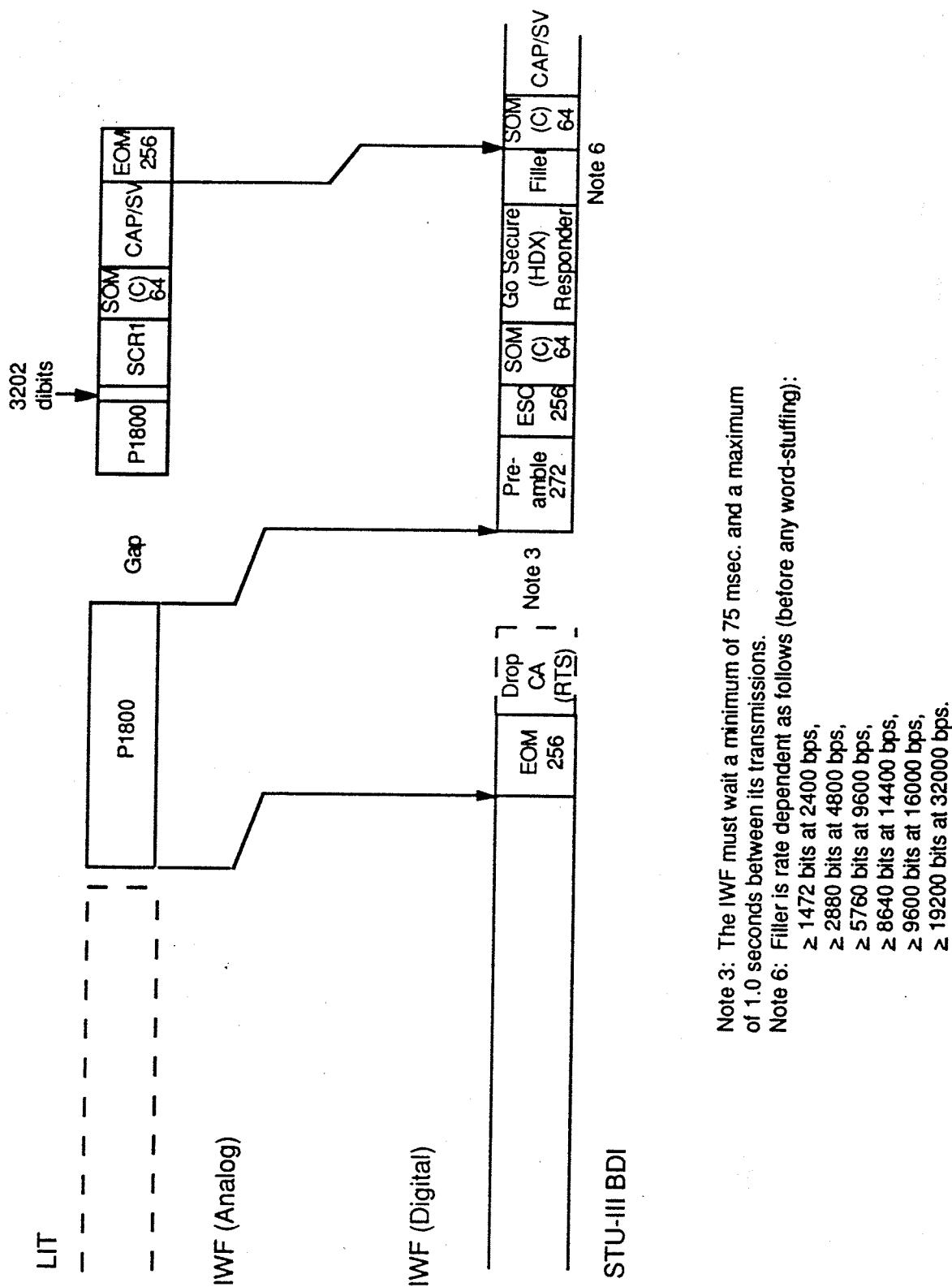


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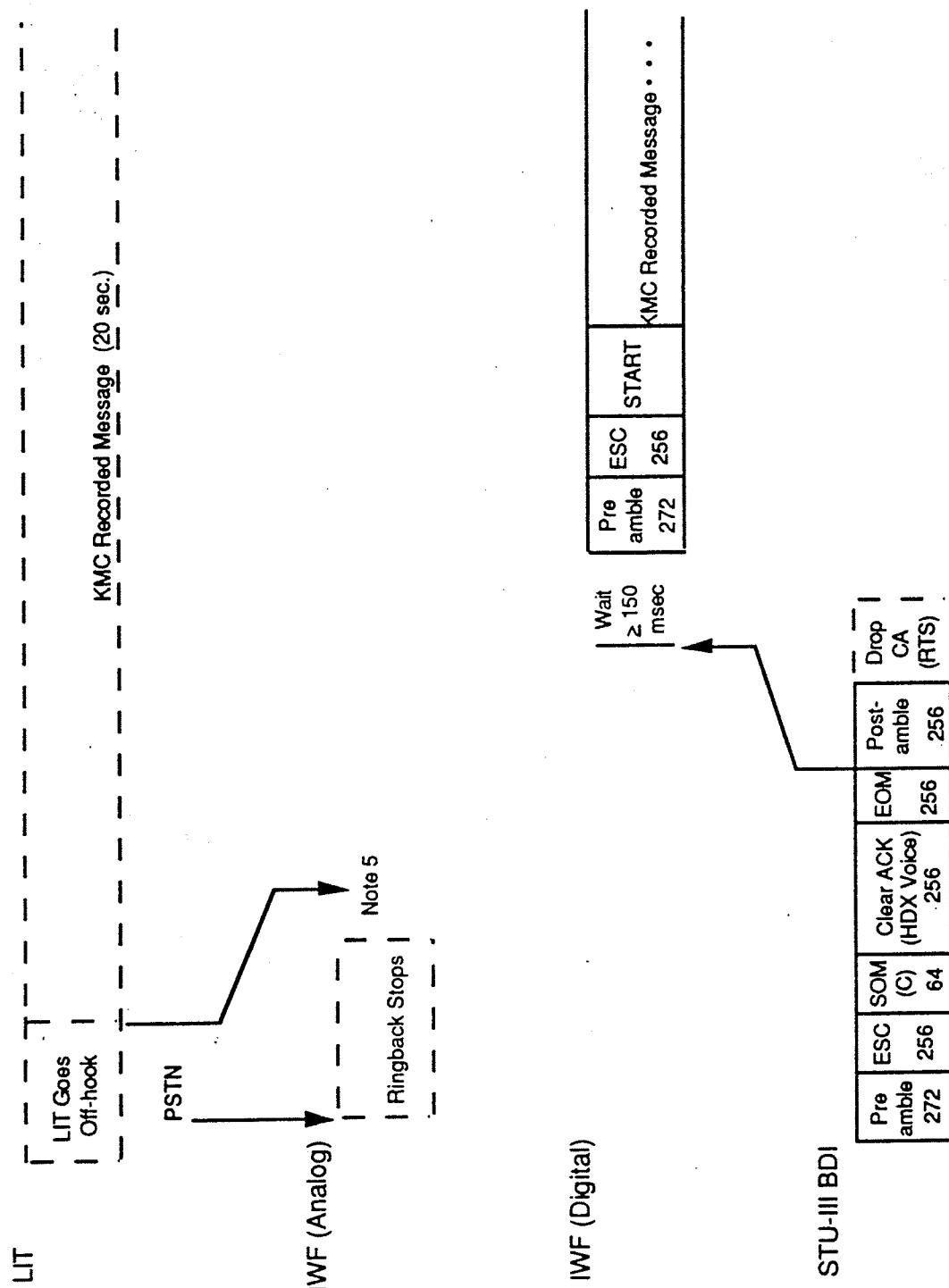


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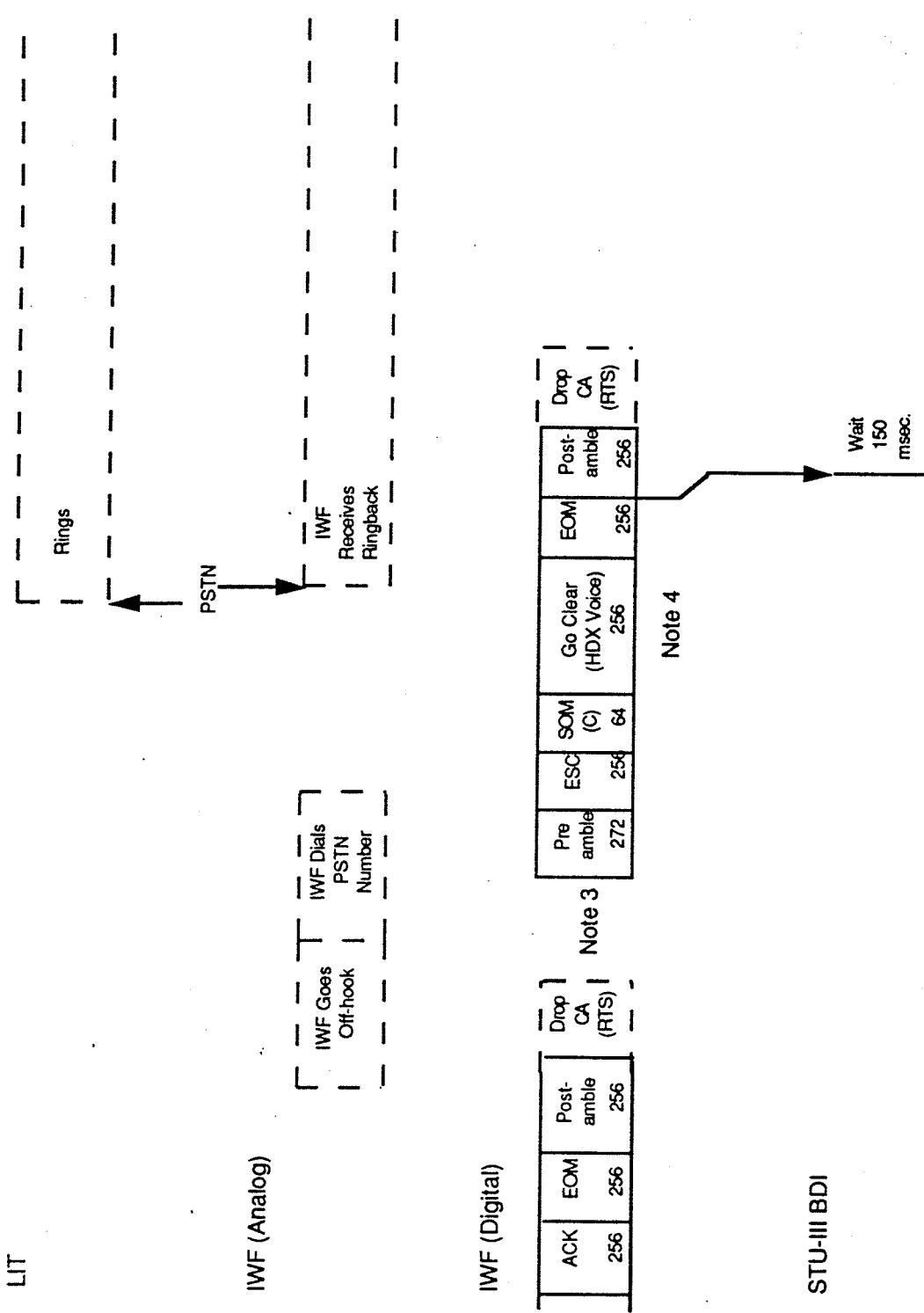


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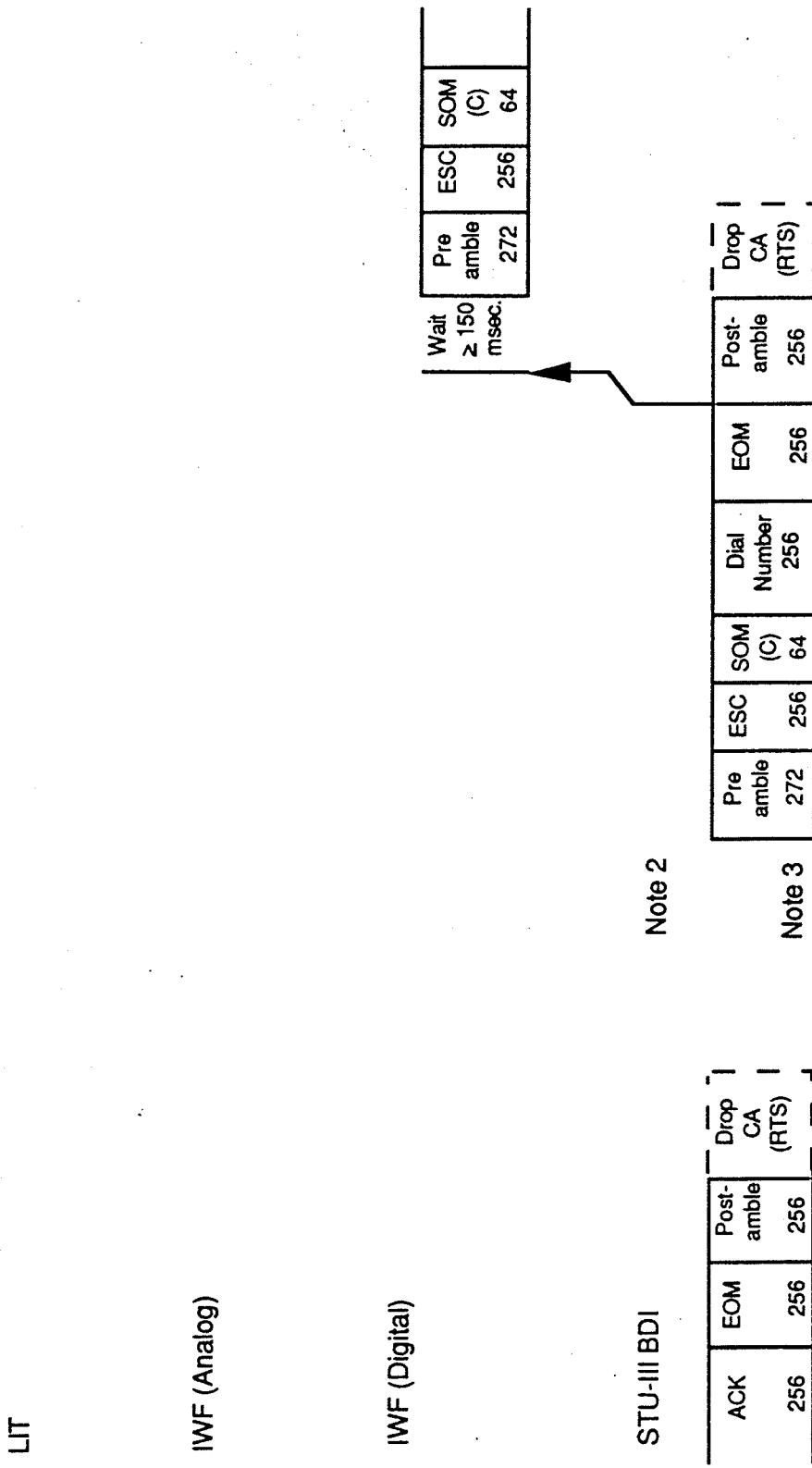


Figure 5.1.1.4-1 (b) STU-III BDI Rekey Signaling Through an IWF (Cont.)

1 INTRODUCTION

1.1 Purpose

This document sets forth requirements for the Black Digital Interface (BDI) for the STU-III family of secure terminals. The purpose of this document is to serve as a basis for mutual understanding among the designer, the developer and the customer, and to ensure interoperability among terminals from different manufacturers. This document may also serve as a basis for system-level tests. The specification which follows is functional and is not intended to suggest any specific implementation.

1.2 Applications

The STU-III family of terminals may be used to communicate voice in either a clear or encrypted mode or encrypted data to another such terminal using the services of a Public Switched Telephone Network (PSTN). As originally designed, STU-III terminals may not be connected directly to any sort of digital network, public or private, nor may external modems be used in conjunction with other types of analog transmission media such as high frequency (HF) radio links.

The Black Digital Interface is designed to permit the usage of the STU-III to be expanded to many types of digital networks. Like-configured STU-IIIs may communicate across these networks and other digital networks with suitable gateways to analog networks that will allow a standard (analog) STU-III to communicate with a STU-III equipped with the Black Digital Interface, referred to herein as a STU-III BDI.

The STU-III BDI may be thought of as a STU-III modified for use over digital networks. With the PSTN interface and modem functions removed, the terminal becomes a "core STU," into which the Black Digital Interface functions are incorporated for EIA/TIA-232-E compatibility. This provides a capability for operating over digital networks. Elsewhere in the network, the modem functions are combined with the Black Digital Interface functions to obtain the Interworking Function (IWF) used for communications between the analog STU-III and the STU-III BDI. Requirements for the analog/digital Interworking Function are specified in Section 5.

L/T

IWF (Analog)

IWF (Digital)

STU-III BDI

Wait ≥ 150 msec.	Pre amble 272	ESC 256	SOM (C) 64	Off-Hook/Z ≥ 512	EOM 256	Post- amble 256	Drop CA (RTS)	—
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Note 1

Pre amble 272	ESC 256	SOM (C) 64	Ring/Y ≥ 512	EOM 256	Post- amble 256	Drop CA (RTS)	—	—
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Wait ≥ 150 msec.	Pre amble 272	ESC 256	SOM (C) 64	—	—	—	—	—
-----------------------------	---------------------	------------	------------------	---	---	---	---	---

Note 1: IWF goes off-hook immediately to the BDI.

The STU-III BDI may be implemented as a stand-alone terminal and utilize the EIA/TIA-232-E physical interface to connect to a digital channel or other communication equipment (DCE). It may also be implemented as part of an integrated terminal, e.g., digital cellular or mobile satellite, where the host system provides clear mode capability as well as signaling and supervision for initial clear call establishment. For this case, there may not be a discrete EIA/TIA-232-E interface between the STU-III BDI and the host equipment; however, the in-band signaling specified herein is still applicable.

1.3 Operational Modes and Capabilities

The STU-III BDI may originate and answer secure voice and data calls at 2400, 4800, 9600, 14400, 16000, and 32000 bps. In addition, many users will require a clear voice or data mode. The standard STU-III uses a POTS (Plain Old Telephone Service) mode of operation to provide clear voice capability. As there is no analog channel to support a POTS mode when the STU-III BDI is used as intended, there can be no analog clear voice mode; however, implementation of a clear voice capability using a vocoder is specified as an option in this document. As stated above, the host network already provides clear voice capability in many applications.

The STU-III BDI supports terminals used in a dedicated or nailed connection. Going off-hook at the originating terminal will alert the terminal at the far end of the connection. It is also possible to selectively alert one of many terminals, provided that the terminals are logically or physically bussed so that all terminals can examine the alerting address and respond if it matches their own. It should be noted that the means of physically bussing STU-III BDI terminals is beyond the scope of this document.

STU-III BDI terminals may also be used with switched digital networks such as ISDN (Integrated Services Digital Network), *provided that* a means of manually selecting the circuit, such as an external voice/data arrangement, is available. Rate Adaption is also required when interfacing a STU-III BDI terminal to ISDN. As specified herein, the BDI does not support network addressing required in such arrangements.

5.1.1.4 STU-III BDI/KMC Rekey Call Setup (MER)

The STU-III BDI user will call the KMC to rekey the terminal or obtain a new Compromised Key List (CKL). After answering the call, the KMC shall initiate the secure call setup and shall determine what information, if any, to send to the BDI terminal. During the remainder of the call the KMC shall interact with the BDI terminal via an IWF in a master/slave relationship. Signaling at the Interworking Function is defined such that a STU-III BDI terminal communicates with the LIT/KMC similar to an analog STU-III. (See Section 4.3.7 for STU-III BDI Rekey requirements).

The STU-III BDI terminal via an IWF shall comply with all rekey signaling requirements defined in FSVS-210 Section 2.3, unless otherwise stated herein. The figures and descriptions presented in this section illustrate the required signaling for rekey operation through an IWF. This section is intended to complement the descriptions in FSVS-210 and does not constitute a complete requirements list.

Figure 5.1.1.4-1 illustrates the scenario in which a fielded STU-III BDI terminal is calling in for rekey via two stage dialing through an IWF. This figure shows the secure call setup through cryptosync and the first KMC Idle Message. An actual rekey call would continue from this point with the LIT and the STU-III BDI terminal exchanging half-duplex secure traffic until the rekey is complete, at which time the LIT would lead the STU-III BDI in a half-duplex release, as illustrated in Figure 5.1.1.3.7-4.

1.4 Requirements Nomenclature

This document specifies each requirement as either a Minimum Essential Requirement (MER), Optional Capability (OC), or a combination of the two. Sections containing specific requirements have titles with the level of specification in parentheses. Titles not containing a parenthetical notation are informational, and do not provide a statement of requirements. The definition of the parenthetical notation is given in Table 1.4-1.

NOTATION	DESCRIPTION
MER	Minimum Essential Requirement. All STU-III BDI equipment shall comply with the given requirement(s).
OC	Optional Capability. The section contains a feature or features which are optional, however, the equipment shall comply with the specification if the described feature or features are implemented.
MER - OC	Compliance is a MER if the related OC is implemented.
MER and OC	The section contains a combination of a MER or multiple MERs and an OC or multiple OCs.
MER or OC	The described feature may be a MER or an OC, depending upon which other features are implemented.
<i>Table 1.4-1 Nomenclature for Level of Requirements</i>	

The relationships between the various requirements and options are illustrated in Figures 1.4-1 and 1.4-2.

dropping carrier. If the receiving STU-III BDI is capable of the restart, it shall cease transmission in preparation for the restart attempt by transmitting EOM and Postamble, and then dropping the line. The IWF shall likewise drop carrier on the analog side. (If the STU-III BDI is unable to restart it shall transmit the standard Failed Call sequence.) Secure call setup shall continue from this point as described in Section 5.1.1.3.1, except that no Message A or Message B transmission is allowed during a restart (per FSVS-210), thus forcing the secure signaling rate to be 2400 bps.

A STU-III BDI detecting a failure and implementing the restart option shall assume the role of the Leader and transmit ESC, SOM(C) or SOM(A) depending on its Initiator/Responder status, Restart Failed Call, EOM, and Postamble, and then drop the line. The IWF shall respond on the analog side by transmitting ESC and Restart Failed Call before dropping the line, and on the digital side by transmitting EOM and Postamble before dropping the line. At this point the STU-III BDI must transmit a Secure Capabilities message to the IWF, indicating that call setup shall proceed at 2400 bps. The IWF shall respond to this message with an ACK.

The analog STU-III, upon detecting the Restart Failed Call message (and assuming it is capable of a restart), shall assume the role of the Follower and drop carrier in preparation for the restart attempt. If the analog STU-III is incapable of the restart it shall transmit a standard Failed Call message per FSVS-210. When the line is idle, the STU-III BDI shall lead a secure call setup as described in Section 5.1.1.3.1. The Message A and Message B transmitted by the IWF and analog STU-III shall indicate 2400 bps operation.

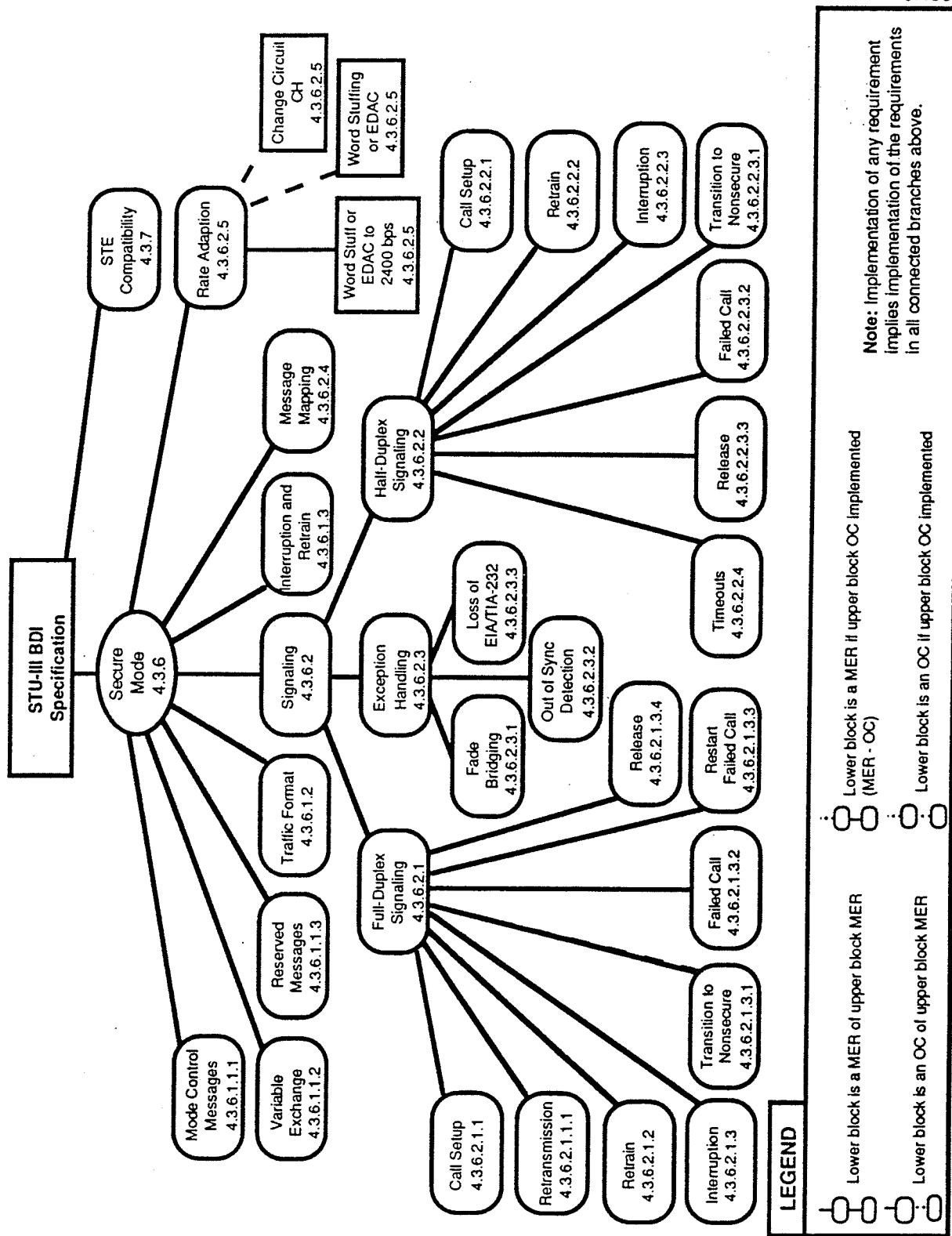


Figure 1.4-1 (a) STU-III Black Digital Interface Requirements Dependency Map

5.1.1.3.8 Interworking Function Modem Support (MER and OC)

As shown in Figure 5.1-1, the Interworking Function is responsible for all the digital data into and out of the modem function. To support the modem function, the Interworking Function must provide data blocks for the modem function to send on the analog line as a modulated signal. Included in this data are control messages, data fields of data messages, and other messages required by FSVS-210. Therefore, the Interworking Function must recognize control messages and the end of data messages, as defined above. For full-duplex transmission, this means that it must have the capability of recognizing the Failed Call, Release, and Abort call interruption messages in secure traffic. For half-duplex transmissions, it must recognize the End of Message field. In either case, when these are recognized, the IWF commands the modem function to terminate the current analog transmission.

The Interworking Function must also take the demodulated data stream from the modem function, monitor the stream for call setup and call interruption messages, and format portions of the stream into messages for the black digital interface.

5.1.1.3.9 Fallback (MER)

The primary BDI requirement for fallbacks is to interoperate with a STU-III via an IWF. The Interworking Function shall support STU-III fallback to 2400 bps signaling as defined in FSVS-210. When modem training on the analog side results in a rate fallback, the IWF shall perform the STU-III BDI signaling specified in Section 5.1.1.3.3.

5.1.1.3.10 Restart Failed Call (MER)

The Interworking Function shall support Restart Failed Call signaling as described in FSVS-210 (for the analog side) and below (for the BDI side). Restart Failed Call processing may be used as an alternative to the standard required Failed Call processing when secure call setup fails due to poor transmission line quality. Note: The STU-III BDI must provide the capability to respond to a restart request as specified below; this is required for interoperation with an analog STU-III via an IWF.

A STU-III detecting a failure and implementing the restart option shall assume the role of the Leader by transmitting the Restart Failed Call message sequence per FSVS-210, and then

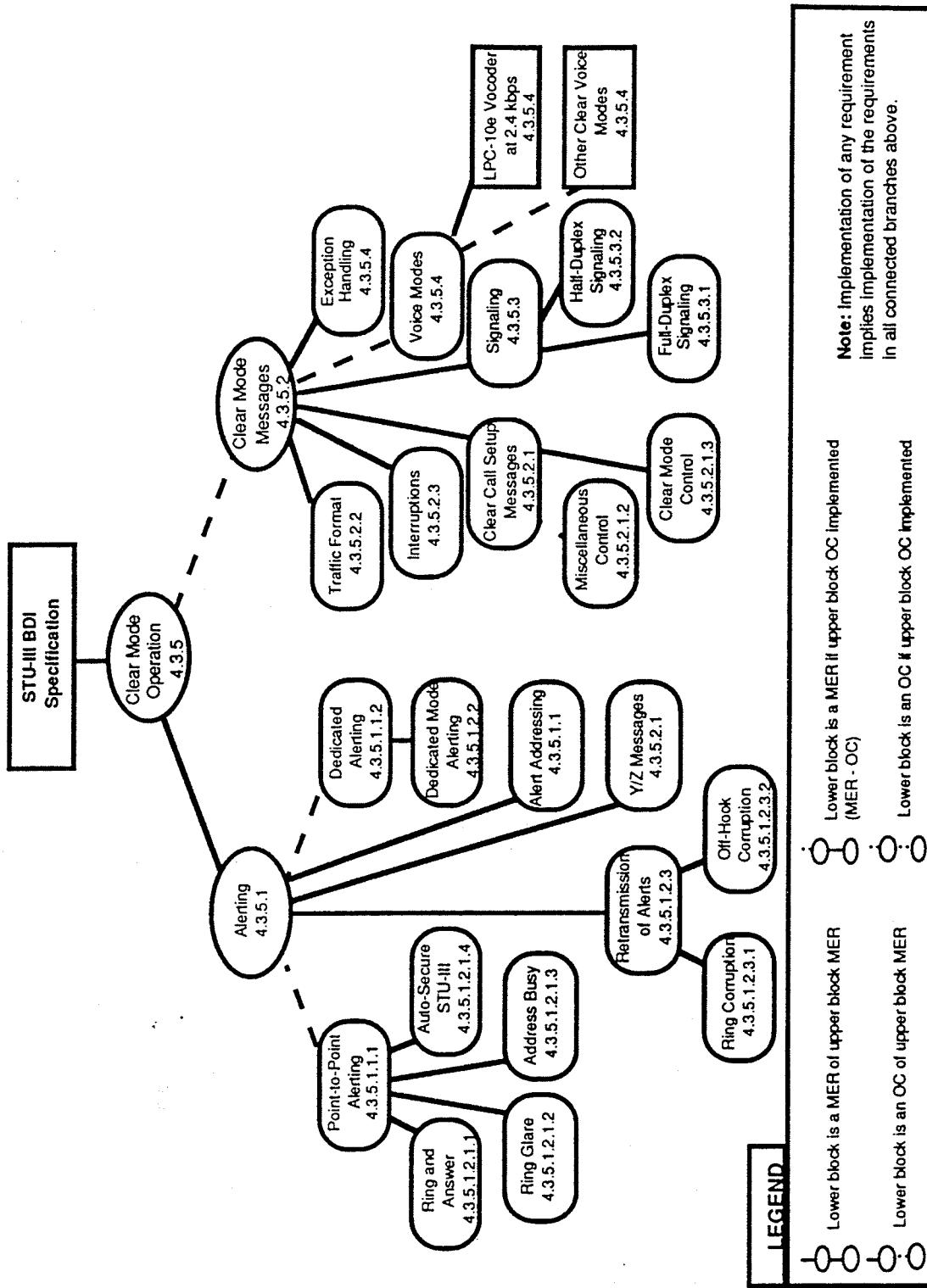


Figure 1.4-1 (b) STU-III Black Digital Interface Requirements Dependency Map (Cont.)

STU-III (Analog) Leader

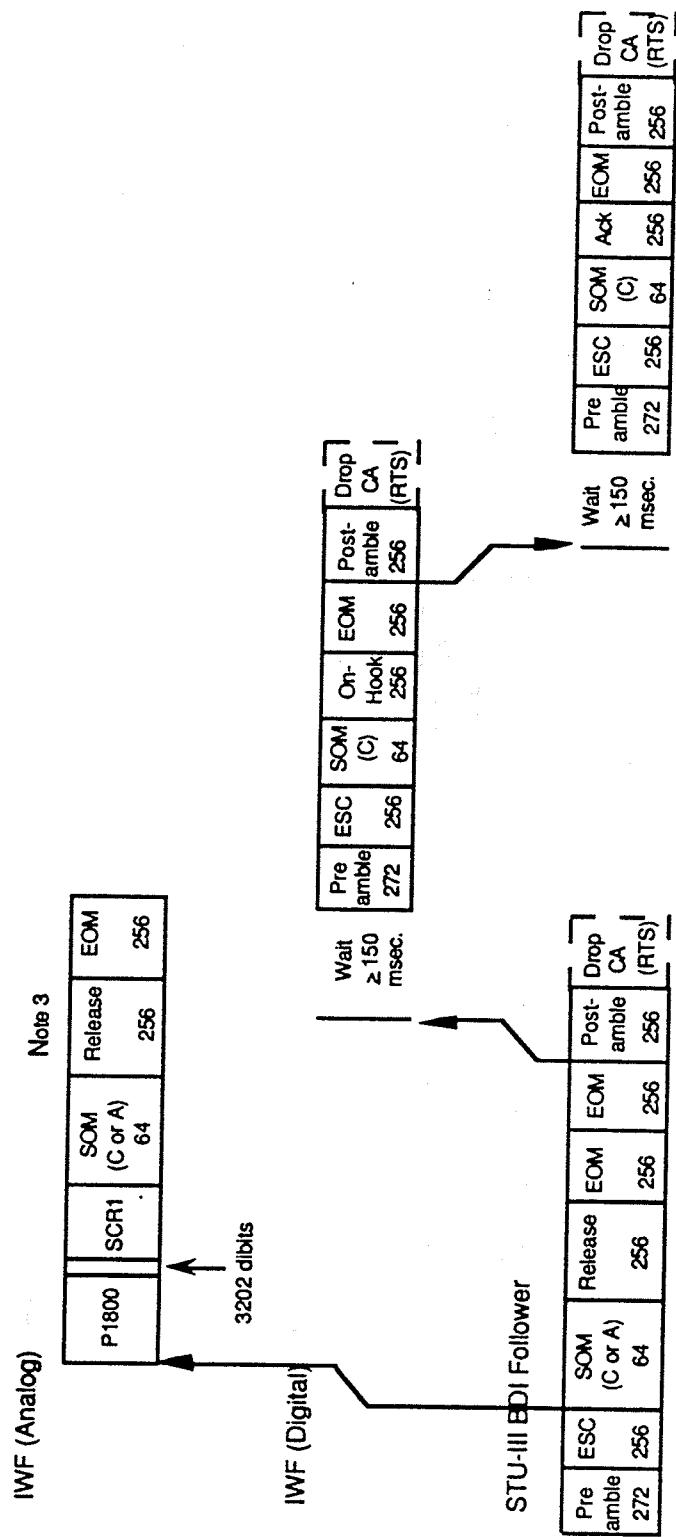


Figure 5.1.13.7-4 (b). IWF Half-Duplex Release Signaling for a STU-III BDI Follower.

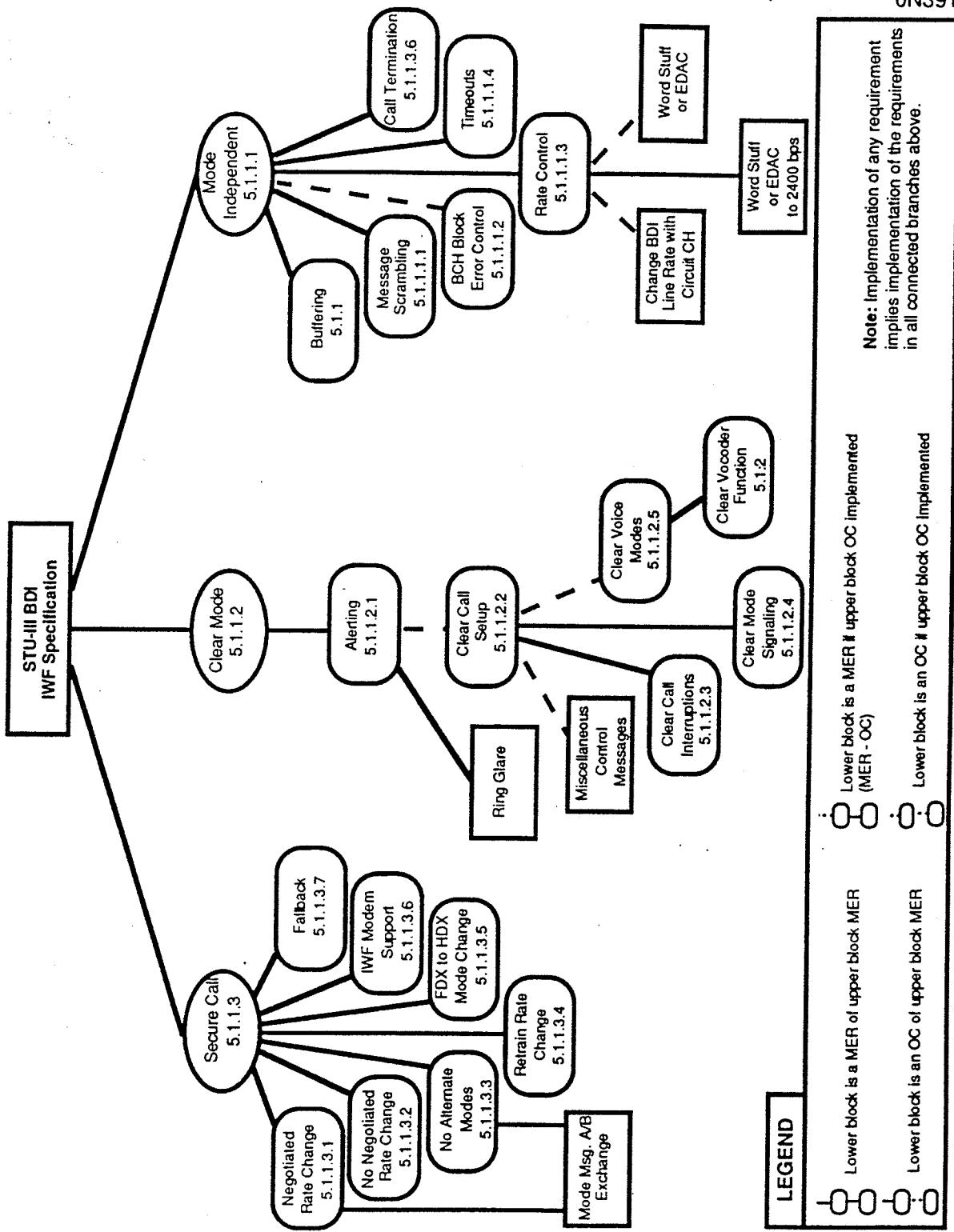
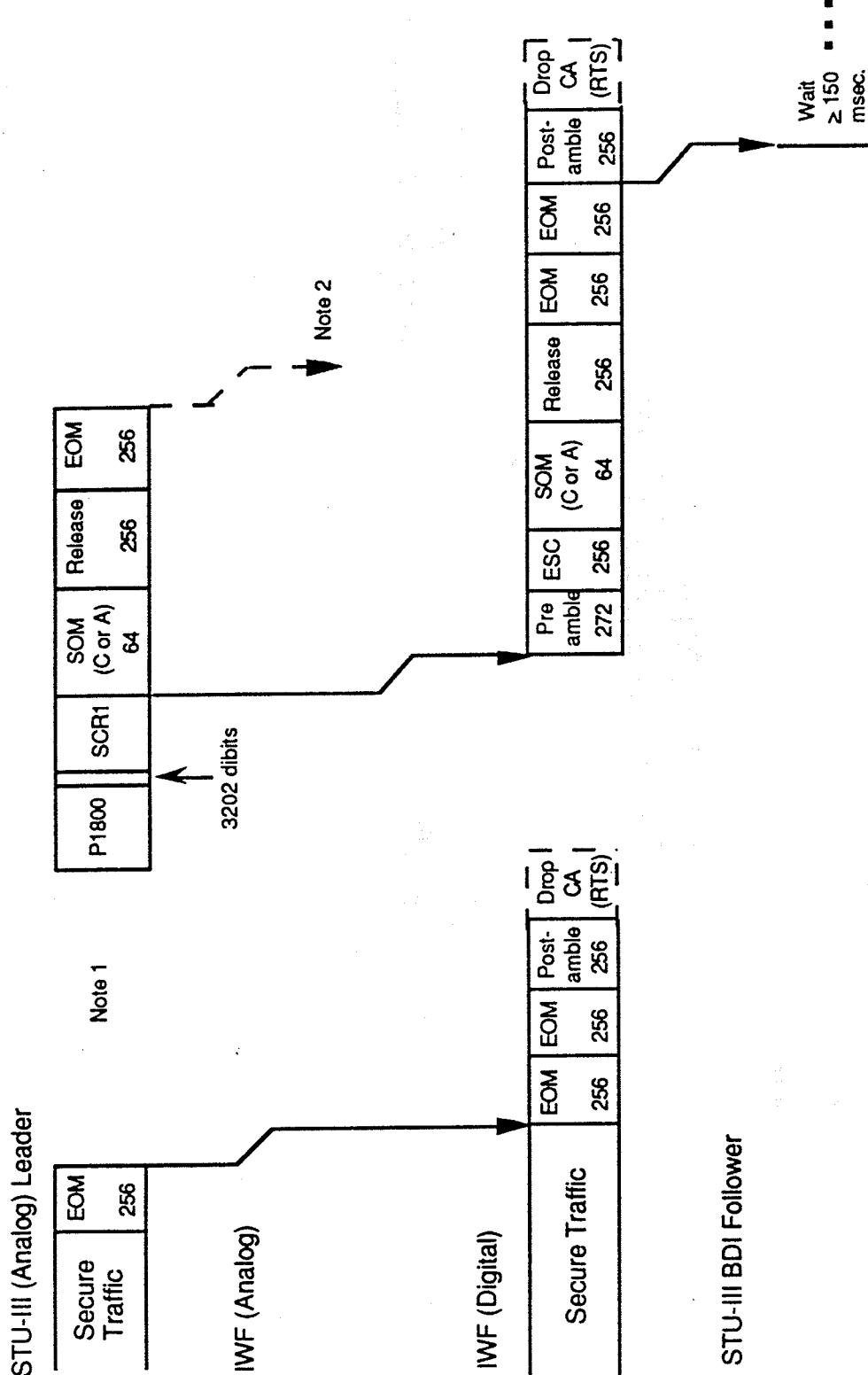


Figure 1.4-2 STU-III BDI IWF Requirements Dependency Map



Note 1: Analog STU-III Leader must drop carrier within 50 msec for a minimum of 35 msec before transmitting again.

Note 2: The IWF may (alternately) transmit the analog Release message at this point, after observing the FSVS-210 HDX turnaround requirements, without waiting to receive a Release from the STU-III BDI.

Figure 5.1.1.3.7-4 (a). IWF Half-Duplex Release Signaling for a STU-III BDI Follower.

2 REFERENCED DOCUMENTS

1. *FSVS Signaling Plan - Interoperable Modes*, FSVS-210 Revision F, 31 March 1992.
2. *FSVS Terminal Performance Specification*, FSVS-220 Revision C, 31 March 1992.
3. *STU-III/R Black Digital Specification* Revision 1.0, 30 October 1990, Motorola Inc.
4. *Transitioning from Analog to Digital Communications, An Infosec Perspective*, February 1990, NSA Central Security Service.
5. *Application Notes for EIA Standard RS-232-C*, Industrial Electronics Bulletin No.9, May 1971, Electronic Industries Association.
6. *Data Communication Networks Open Systems Interconnection (OSI) System Description Techniques Recommendations X.200-X.250*, Fascicle VIII.5, 8-19 October 1984.
7. *Connector, Electric, Rectangular, Non-Environmental, Miniature, Polarized Shell, Rack and Panel, General, Specification for*, MIL-C-24308, Revision C, Amendment 1, Jan. 26, 1990.
8. *Interface Between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange*, EIA/TIA Standard EIA/TIA-232-E, July 1991.

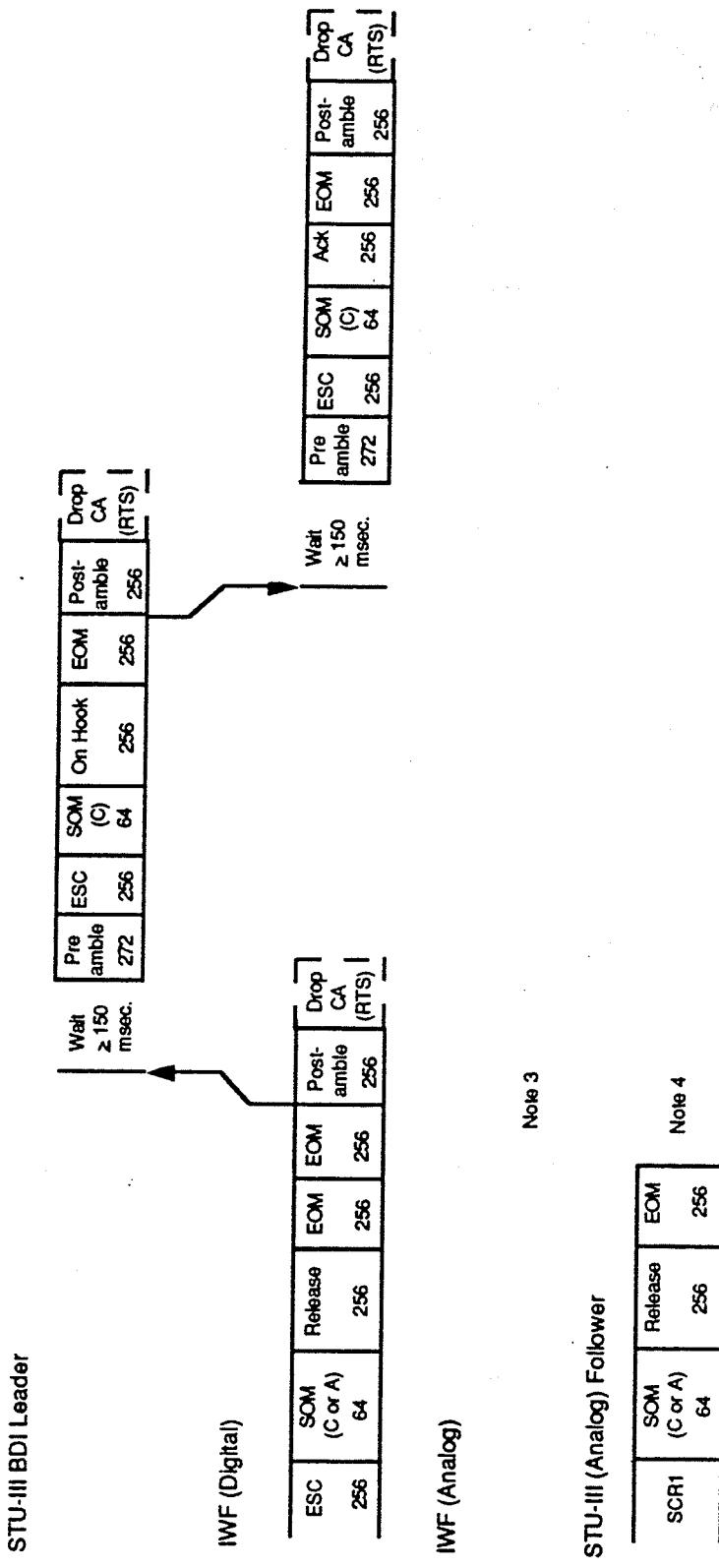


Figure 5.1.13.7-3 (b). IWF Half-Duplex Release Signaling for a STU-III BDI Leader

3 TERMS AND DEFINITIONS

TERM	DEFINITION
ACK	Acknowledgement
BCH	Bose, Chaudhuri, and Hocquenghem (error correcting code)
BDI	Black Digital Interface
BDN	Black Digital Network
CAP/SV	Capability/Status vector
CS	Crypto Synchronization
DCD	Data Carrier Detect
DCE	Data Circuit-Terminating Equipment
DSR	DCE Ready (Data Set Ready)
DTE	Data Terminal Equipment
DTR	DTE Ready (Data Terminal Ready)
EOM	End of Message
ESC	Escape Message
ESD/ESCD	echo suppressor disable/echo suppressor/canceller disable
FDX	Full-Duplex
FEC	Forward Error Correction
GPA/GPC	Modem Scrambler Designations (Answering/Calling)
HDX	Half-Duplex
HF	High Frequency
ISDN	Integrated Services Digital Network
IWF	Interworking Function
LMR	Land Mobile Radio
MID	Message Identifier
MPT	Mobile Portable Terminal
MSAT	Mobile Satellite System
NACK	Negative Acknowledgement

Table 3-1 (a) Terms and Definitions

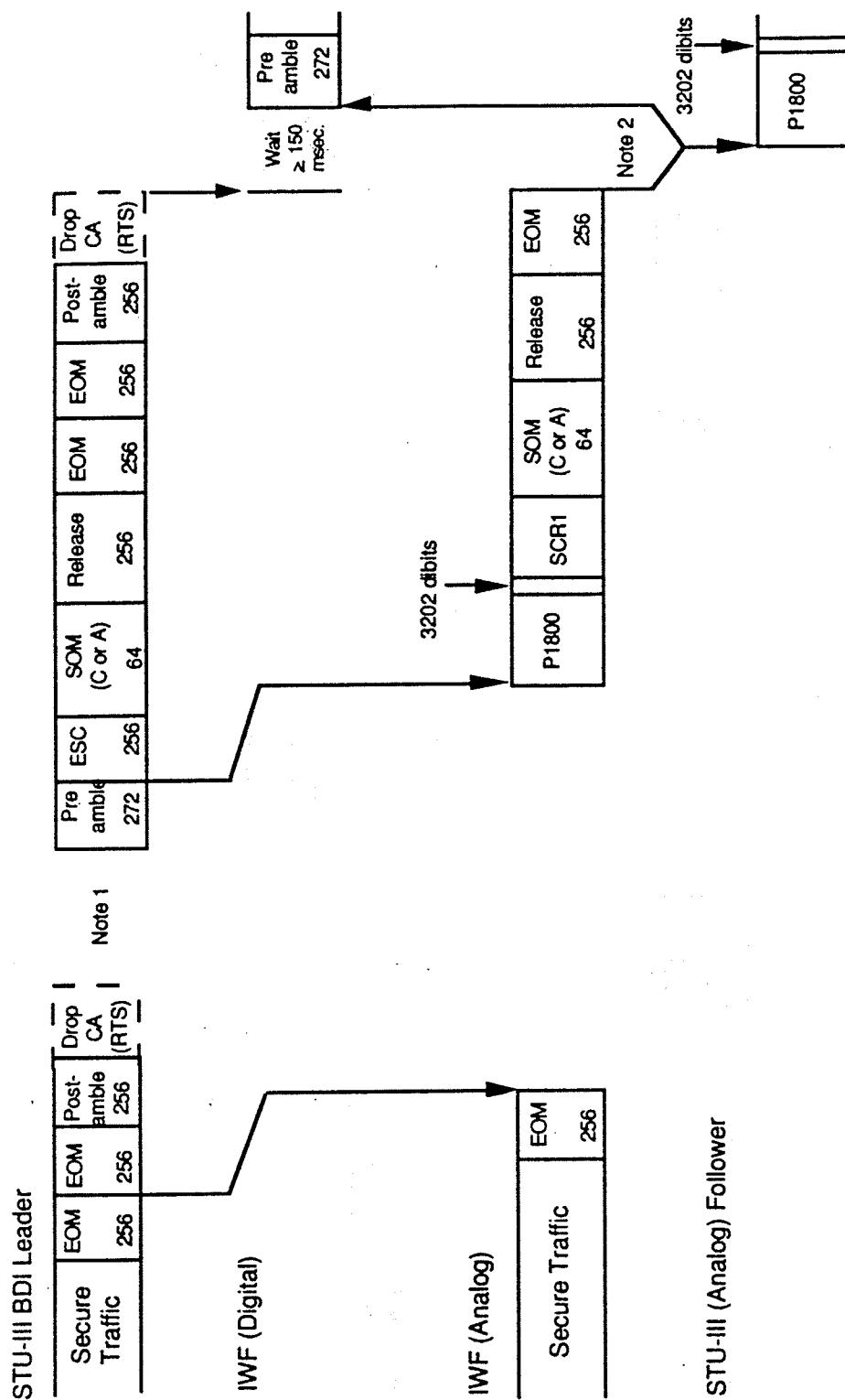


Figure 5.1.1.3.7-3 (a). IWF Half-Duplex Release Signaling for a STU-III BDI Leader

Note 1: The Leader terminal must wait a minimum of 75 ms, and a maximum of 1.0 seconds after dropping the line before transmitting again.

Note 2: The IWF may go on-hook to the PSTN at this point, and then source a Release message at least 150 msec after receiving the second EOM from the STU-III BDI.

TERM	DEFINITION
PSTN	Public Switched Telephone Network
RCC	Random Component Cipher
RTR	Retrain Request
RTS	Request to Send
SCR1	Scrambled Ones (message pattern)
SOM(A)	Start of Message for GPA scrambled messages
SOM(C)	Start of Message for BDI-specific or GPC scrambled messages
STE	Secure Terminal Equipment
STU	Secure Telephone Unit
TC	Terminal Cipher

Table 3-1 (b) Terms and Definitions (Cont.)

STU-III (Analog) Leader

IWF (Digital)

IWF (Analog)

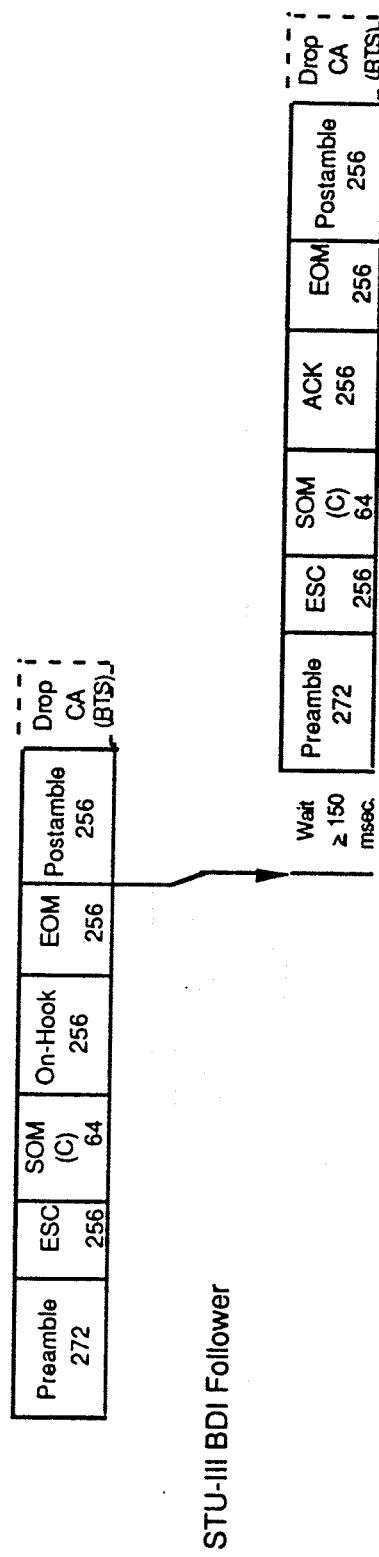


Figure 5.1.1.3.7-2 (b) IWF Full-Duplex Release Signaling for a STU-III BDI Follower (Cont.)

4 GENERAL INTERFACE REQUIREMENTS

4.1 Interface Block Diagram

This section describes the BDI and its relationship to other elements of the STU-III by presenting a block diagram of a standard (analog) STU-III, including all interfaces. A set of functions is identified and called the "Core STU." A second diagram is then presented, similar to the first but with the Core STU¹ functions logically interfaced to the BDI functions.

Figure 4.1-1 illustrates a generalized STU-III with appropriate functions grouped together and labelled "Core STU." This functionality, with the possible exception of Clear Voice (optional), also exists in configurations using the Black Digital Interface.

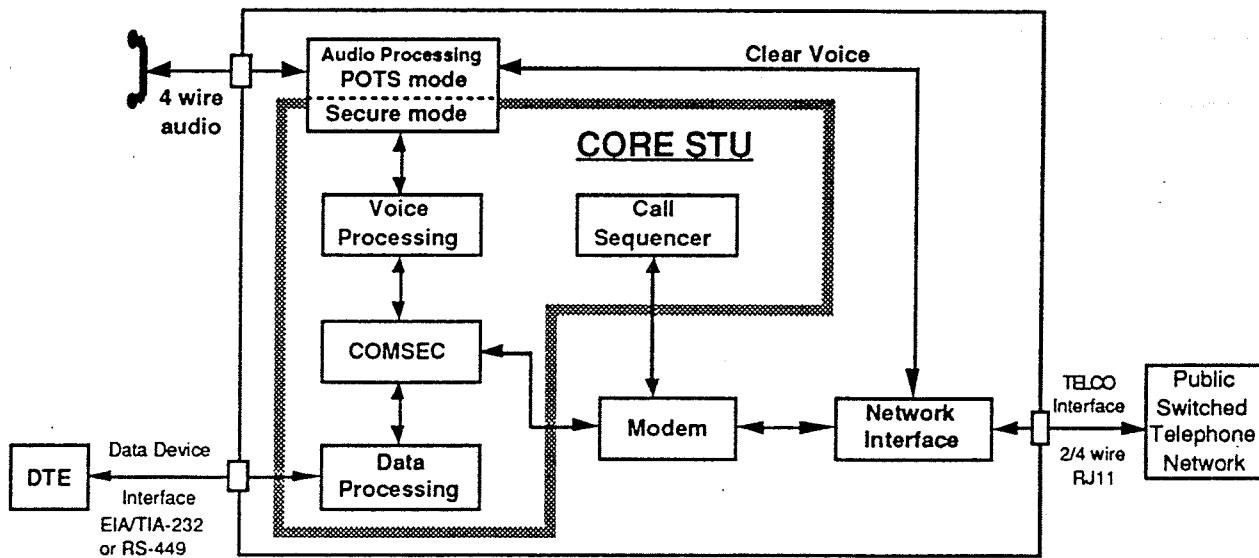
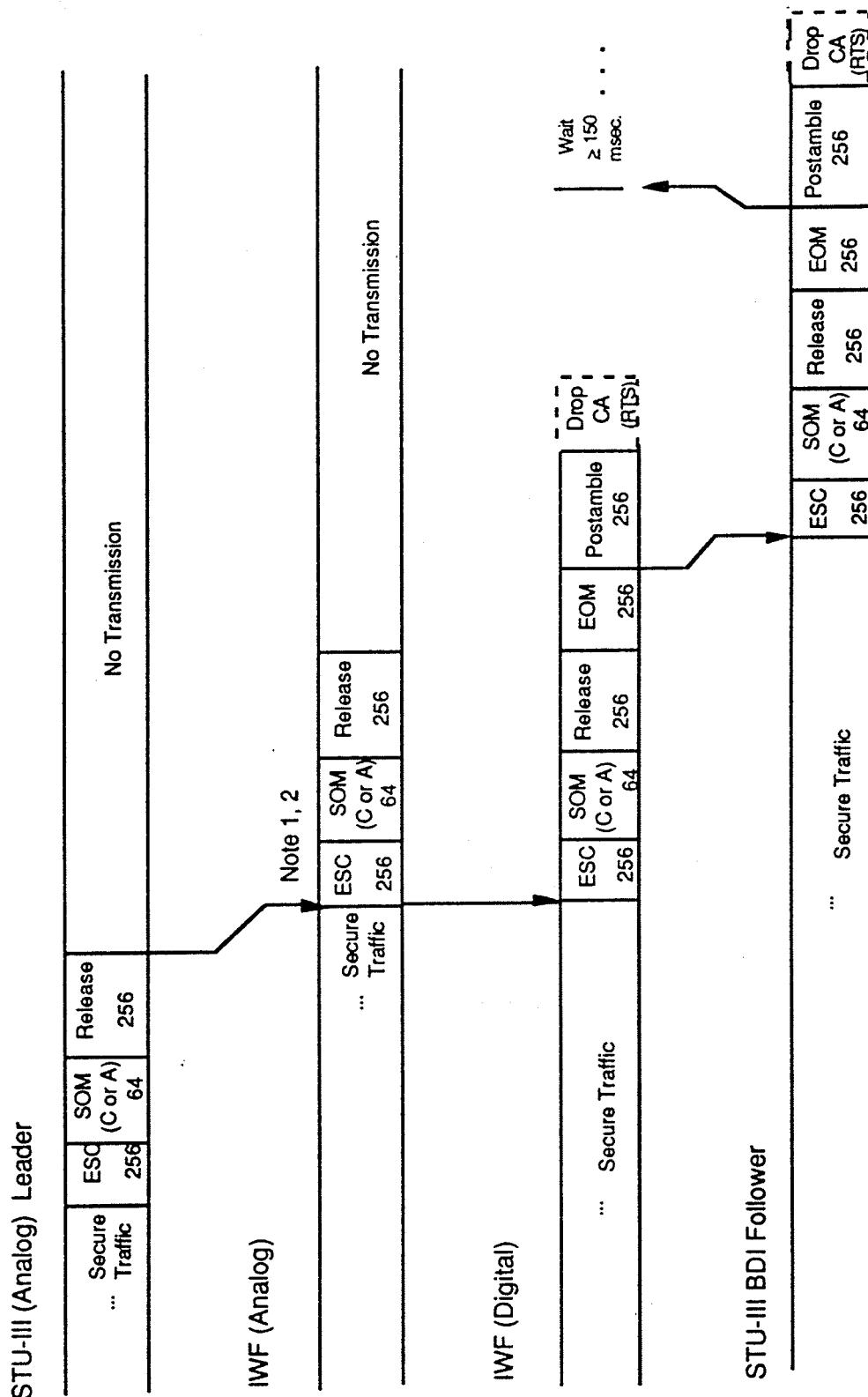


Figure 4.1-1 Block Diagram of a STU-III with "Core STU" Functions Delimited

Figure 4.1-2 shows the functions labelled "Core STU" and identifies the Black Digital Interface. This is conceptual and not meant to imply that the interface between the Core STU and the BDI is the same as the interface to the modem in Figure 4.1-1.

¹It should be noted that the "Core STU" is a logical construct defined to elucidate the functionality of the BDI. *It is NOT a requirement that the BDI-equipped STU-III be partitioned this way.* Functions may be migrated across boundaries, or the functionality may be totally merged as the developer sees fit.



- Note 1: The analog side of the IWF may not transmit a Release under certain conditions.
 Note 2: The analog side of the IWF may go on-hook anytime after receiving a Release from the analog STU-III Leader.

Figure 5.1.1.3.7-2 (a) IWF Full-Duplex Release Signaling for a STU-III BDI Follower

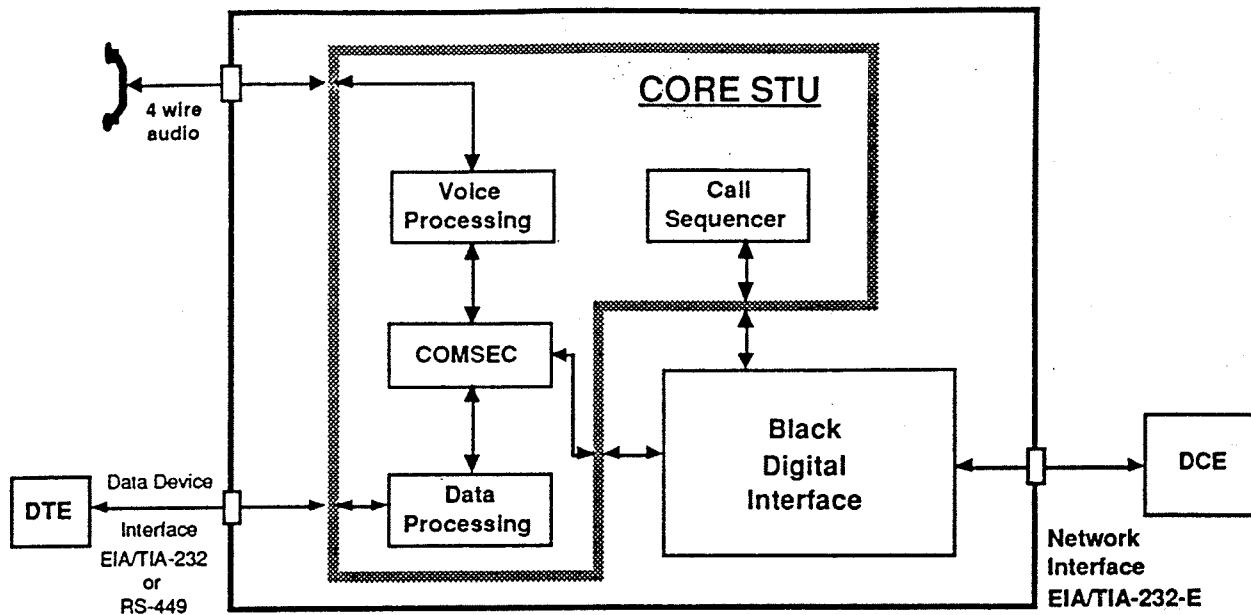


Figure 4.1-2 Block Diagram of a STU-III BDI Terminal (a BDI added to the "Core STU")

4.2 EIA/TIA-232-E Interface to DCE

The EIA/TIA-232-E interface, identified as the Black Digital Interface in Figure 4.1-2, is the major functional addition to the STU-III design. This section specifies the mandatory and optional mechanical, electrical and protocol requirements for the interface. Many of the requirements here are specified by incorporation of EIA Specification EIA/TIA-232-E (Reference 8). The following text in the remainder of Section 4.2 has been adapted from Reference 8. Common usage signal names are given in parentheses.

The description that follows is the interface requirement for all STU-III BDI terminals. In addition, terminals may provide an optional, user-selectable version of this interface, ignoring certain signals, as long as the specified interface can be enabled by the user when needed. This optional interface shall not alter the signaling protocol. At all times, the interface shall use clock and data circuits.

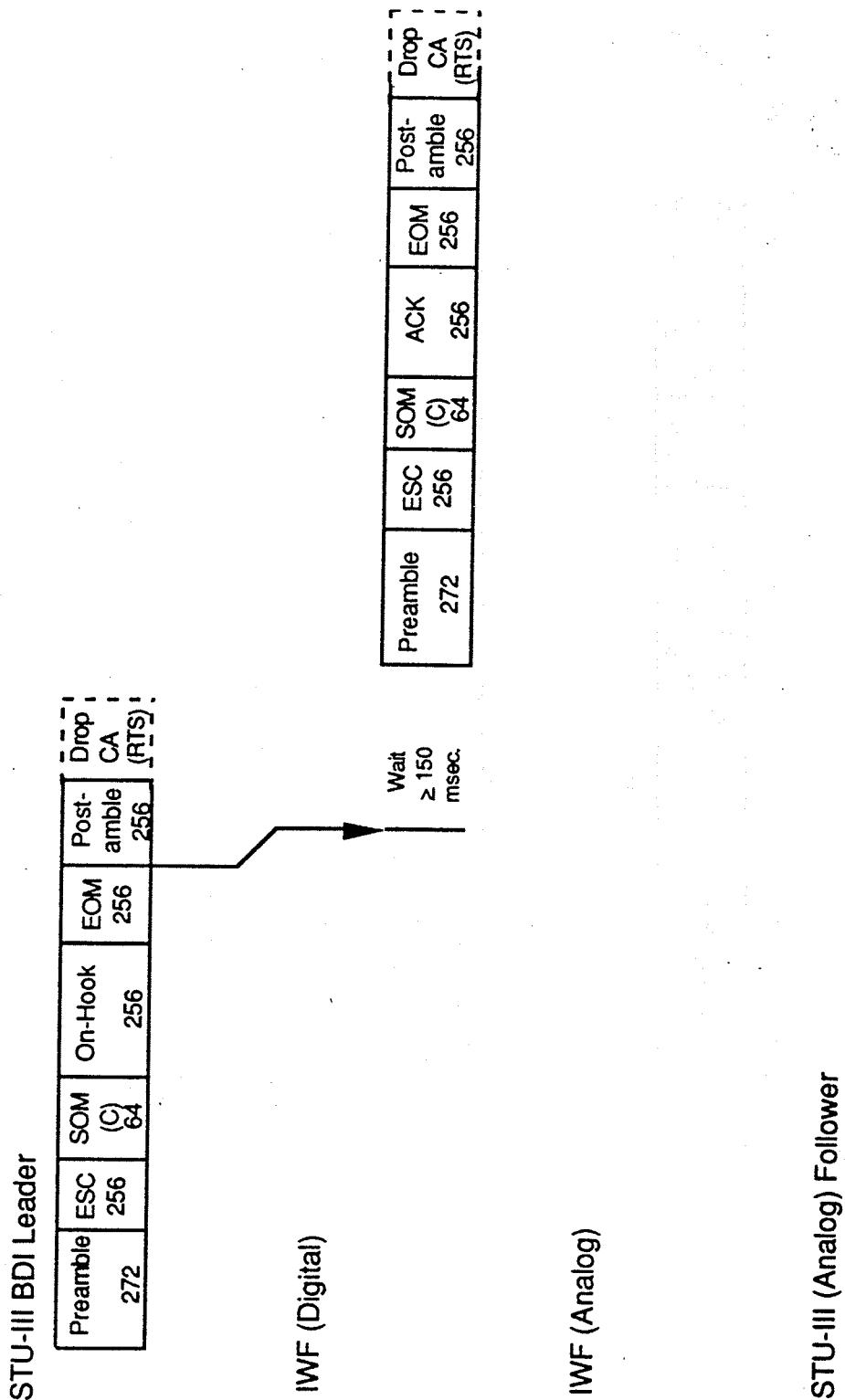


Figure 5.1.1.3.7-1 (b) IWF Full-Duplex Release Signaling for a STU-III BDI Full-Duplex Leader (Cont.)

4.2.1 Mechanical Interface Requirements (MER)

The interface between the STU-III BDI and the Data Circuit-Terminating Equipment (DCE) shall be located at a pluggable connector signal interface point. The connector shell shall be a standard 25-position D connector with male pins installed. Components for this connector may be selected from procurement specification MIL-C-24308, latest edition.

The shell of the connector shall be electrically bonded to the metallic chassis of the STU-III electronic assembly, or alternatively, to the same point at which the BLACK signals within the STU-III have their common return. Due regard for maintaining COMSEC and TEMPEST requirements shall be taken.

The assignment of electrical circuits to connector pins and their nomenclature shall be as specified in Table 4.2.1-1. All other pin positions may or may not have pins installed at the designer's option. If pins are installed, it is recommended that they be electrically connected to Circuit AB.

4.2.2 Electrical Signal Characteristics (MER)

Section 2 of Reference 8 is herein adopted in its entirety.

4.2.3 Electrical Circuit Characteristics

The following sections provide information on specific STU-III BDI circuits. It should be noted that transient signals may be present on these circuits until the STU-III BDI terminal has completed its initialization process.

4.2.3.1 Circuit AA - Protective Ground (FG) (MER)

Direction: Not Applicable

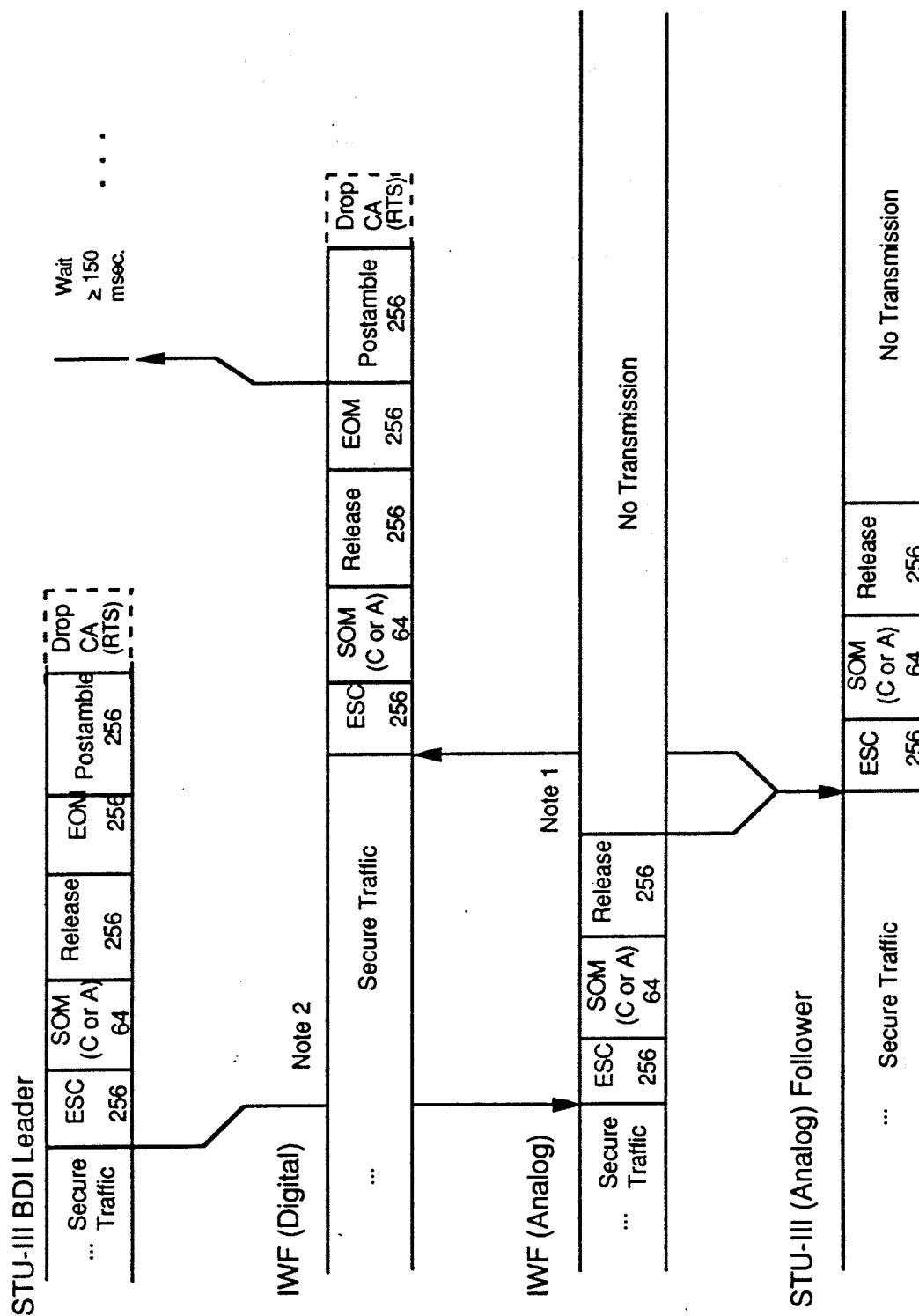


Figure 5.1.1.3.7-1 (a) IWF Full-Duplex Release Signaling for a STU-III BDI Full-Duplex Leader

PIN No.	CIRCUIT	DESCRIPTION
1	AA	Protective Ground
2	BA	Transmitted Data
3	BB	Received Data
4	CA	Request to Send
5	CB	Clear to Send
6	CC	DCE Ready
7	AB	Signal Ground (Common Return)
8	CF	Received Line Signal Detector (Data Carrier Detect, or DCD)
15	DB	Transmission Signal Element Timing (DCE Source)
17	DD	Receiver Signal Element Timing (DCE Source)
20	CD	DTE Ready
21	CG	Signal Quality Detector*
22	CE	Ring Indicator*
23	CH	Data Signal Rate Selector (DTE Source)*
24	DA	Transmit Signal Element Timing (DTE Source)*
<i>Table 4.2.1-1 Interface Pin Assignments</i>		

* Optional signal - not a mandatory requirement.

5.1.1.3.7 Signaling for Release (MER)

The IWF shall facilitate Release processing when the user places the handset on hook or otherwise disconnects the call. Processing for two BDI terminals is specified in Section 4.3.6.2.1.3.4. With the IWF, a straightforward analog/digital mapping of the Release sequence is followed by an On-Hook/Ack exchange on the digital side. Release signaling begins when the Leader terminates secure traffic using an Escape sequence with the Release message. The Follower's secure traffic ends upon detection of the Leader's Release message. The Follower immediately sends an Escape sequence with a Release message, drops carrier, and notifies the user. The IWF and STU-III BDI shall then engage in an On-Hook/Ack message exchange with the Release Leader also acting as the On-Hook Leader.

Figure 5.1.1.3.7-1 illustrates the Release processing for a FDX STU-III BDI Leader. Figure 5.1.1.3.7-2 illustrates the Release processing for a FDX STU-III BDI Follower. Note that when the analog STU-III leads the Release, the IWF may not transmit a Release on the analog side under certain conditions. Figure 5.1.1.3.7-3 illustrates the Release for a HDX STU-III BDI Leader, while Figure 5.1.1.3.7-4 is for a HDX STU-III BDI Follower.

This circuit is not strictly an interchange circuit. The exact connection point is beyond the scope of this document and must be made in accordance with good engineering practice.

4.2.3.2 Circuit AB - Signal Ground (SG) (MER)

Direction: Not Applicable

This conductor shall establish the ground potential for all other interchange circuits except AA.

4.2.3.3 Circuit BA - Transmitted Data (TD) (MER)

Direction: From the STU-III BDI

Signals on this circuit are generated by the STU-III BDI and are transferred to the DCE for transmission to a remote STU-III BDI or other compatible DTE. The STU-III BDI shall hold Circuit BA in the Marking Condition when no data are transmitted.

In all modes the STU-III BDI shall not transmit data unless an ON condition is present on all active circuits in the following list:

1. Circuit CA (Request to Send)
2. Circuit CB (Clear to Send)
3. Circuit CC (DCE Ready)
4. Circuit CD (DTE Ready)

4.2.3.4 Circuit BB - Received Data (RD) (MER)

Direction: To the STU-III BDI

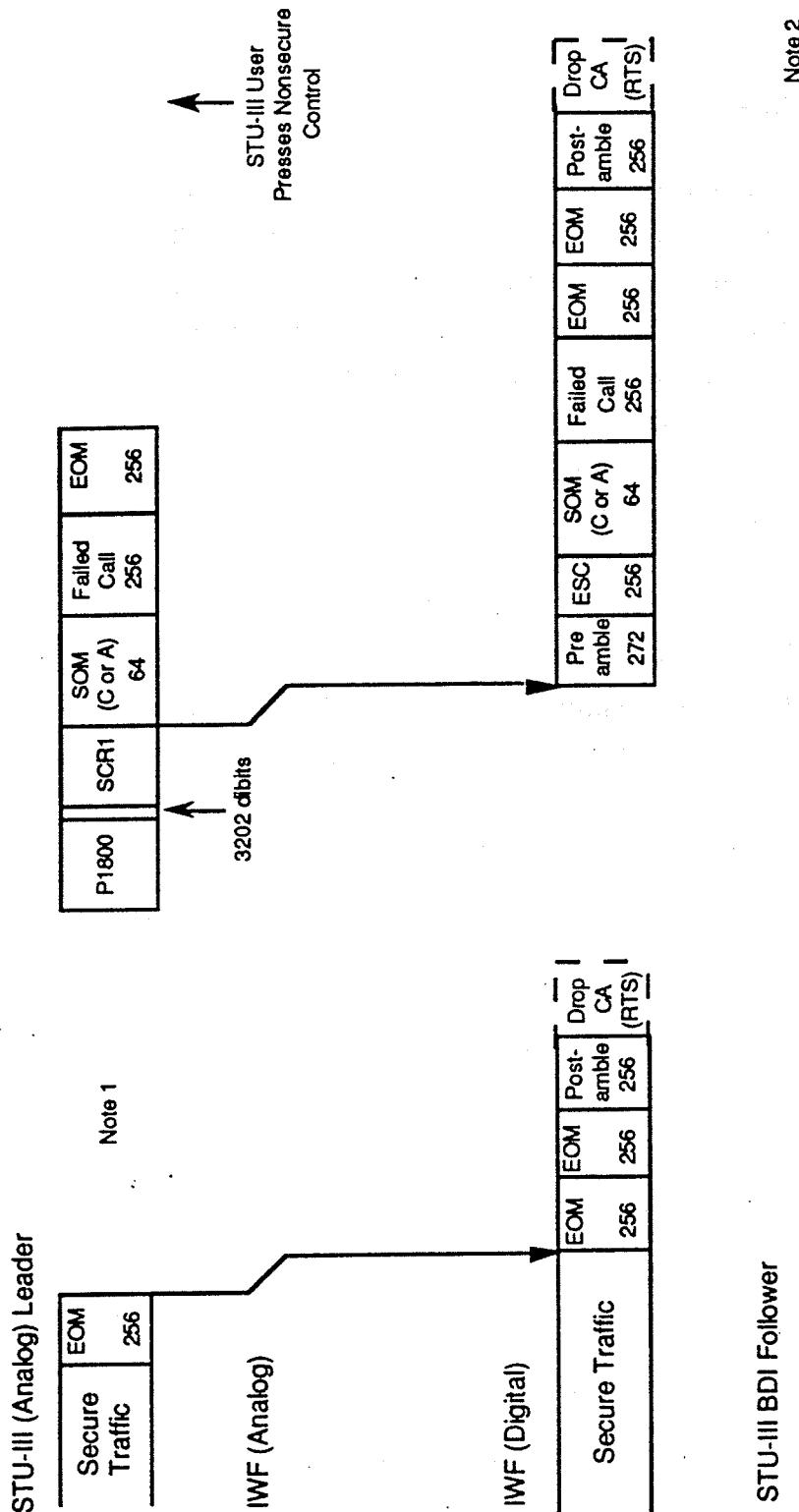


Figure 5.1.1.3.6-4. IWF Half-Duplex Failed Call Signaling for a STU-III BDI Follower

Signals on this circuit are generated by the receiving signal converter in response to data signals received from the remote DTE. Circuit BB is held in the binary ONE (Marking) condition at all times when circuit CF (Received Line Signal Detector) is in the OFF condition.

4.2.3.5 Circuit CA - Request to Send (RTS) (MER)

Direction: From the STU-III BDI

This circuit is used to condition the local data communication equipment for data transmission and, on a half-duplex channel, to control the direction of data transmission.

A transition from OFF to ON shall instruct the DCE to enter the transmit mode. A transition from ON to OFF shall instruct the DCE to complete transmission of all data previously transferred across the interface point on Circuit BA and then assume a non-transmit mode.

Circuit CA goes ON when the device transitions to the off-hook state, either manually or through the use of an alerting protocol message, or when a message is ready for transmission. Circuit CA transitions from ON to OFF when the device has completed sending a message. When circuit CA is turned OFF, it shall not be turned ON again until circuit CB has been turned off by the DCE. It is permissible to turn Circuit CA ON at any time when circuit CB is off, regardless of the state of any other interchange circuit.

4.2.3.6 Circuit CB - Clear to Send (CTS) (MER)

Direction: To the STU-III BDI

Signals on this circuit are generated by the DCE to indicate whether or not it is ready to transmit data.

The ON condition, together with the ON condition on interchange circuits CA, CC, and CD, is an indication to the STU-III BDI that signals presented on Circuit BA will be transmitted to the communication channel.

4.2.3.7 Circuit CC - DCE Ready (DSR) (MER)

Direction: To the STU-III BDI

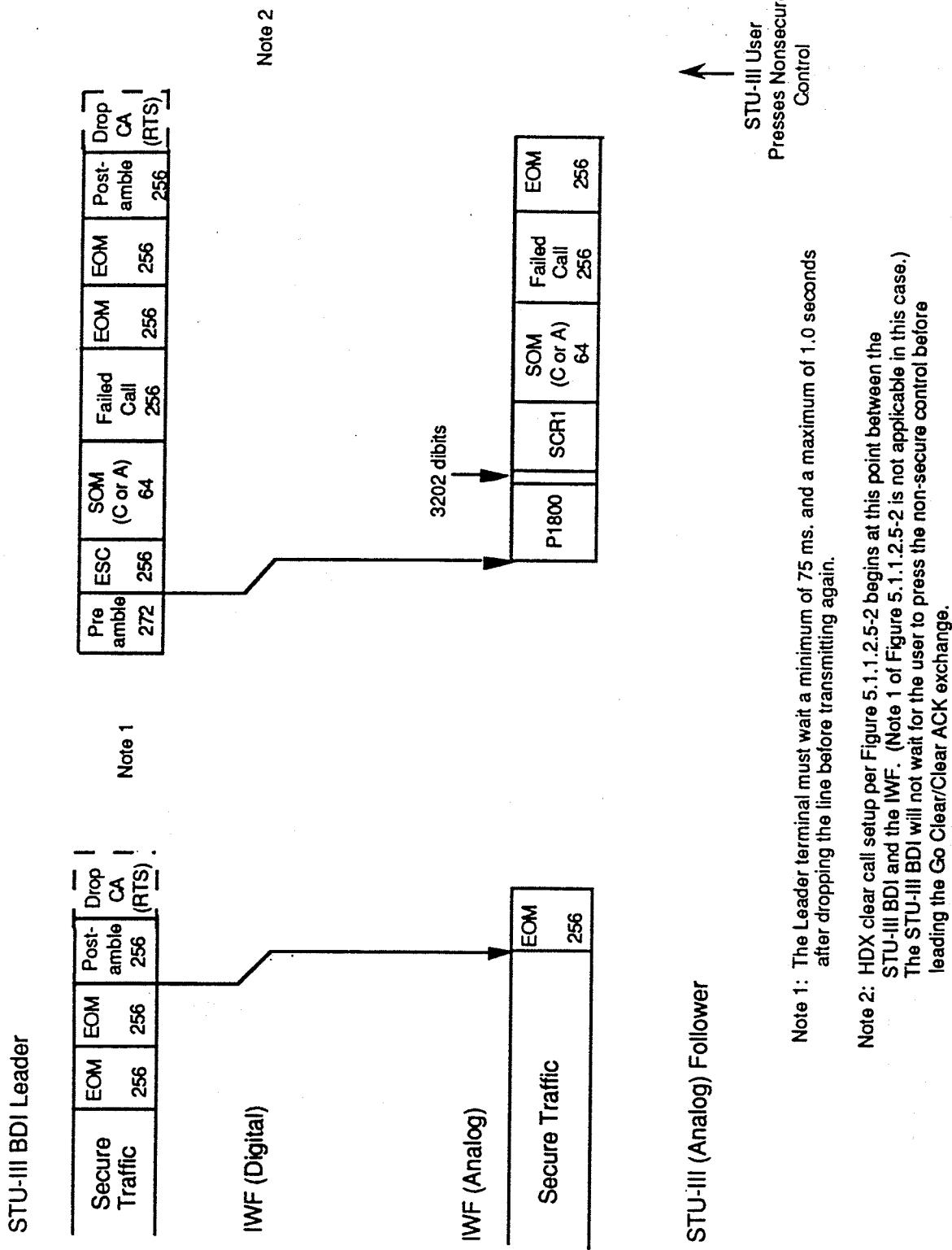


Figure 5.1.1.3.6-3. IWF Half-Duplex Failed Call Signaling for a STU-III BDI Leader

Signals on this circuit are used to indicate the status of the local DCE. The ON condition shall be interpreted by the STU-III BDI to mean:

1. The local DCE is connected to a communication channel.
2. The local DCE is not in a test mode.
3. The local DCE has completed any functions required by the transmission facility for the establishment of a data channel.

When the OFF condition occurs anytime during a call with Circuit CD ON, the STU-III BDI shall revert to the alerting idle state and go on-hook if the condition persists longer than ten seconds. Any subsequent ON condition shall be considered a new call.

4.2.3.8 Circuit CD - DTE Ready (DTR) (MER)

Direction: From the STU-III BDI

Signals on this circuit are used to control switching of the DCE to the communications channel. The ON condition shall prepare the DCE to be connected to the communications channel and, if applicable, maintain the connection established by external means. The STU-III BDI shall set Circuit CD to the ON condition when it is powered on.

The OFF condition will cause the DCE to remove itself from the communications channel following the completion of any "in-process" communications. The OFF condition shall not disable the operation of circuit CE (Ring Indicator.)

4.2.3.9 Circuit CE - Ring Indicator (RI) (OC)

Direction: To the STU-III BDI

The ON condition of this circuit indicates that a ringing signal is being received on the communications channel. If supported by the DCE, this circuit may need to be monitored. Circuit CE may be used to indicate an incoming call.

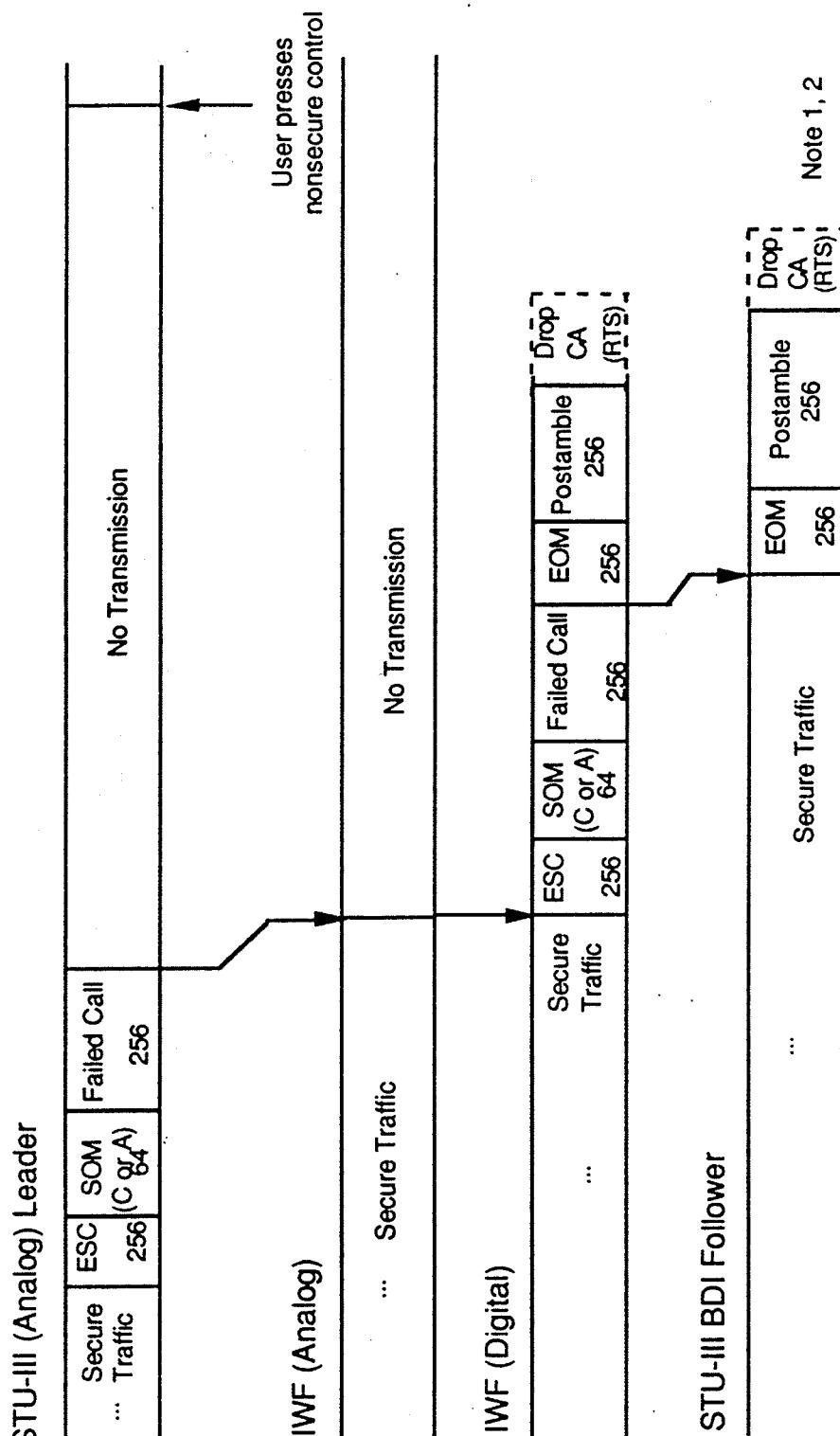


Figure 5.1.1.3.6-2 IWF Full-Duplex Failed Call Signaling for a STU-III BDI Full-Duplex Follower

4.2.3.10 Circuit CF - Received Line Signal Detector (DCD) (MER)

Direction: To the STU-III BDI

The ON condition of this circuit is presented when the DCE is receiving a signal that meets its suitability criteria. On half-duplex channels, Circuit CF is held to the OFF condition whenever circuit CA is in the ON condition plus a brief time following the transition of CA to an OFF condition.

The STU-III/BDI shall accept the loss of Circuit CF as an end-of-transmission indicator if the EOM/Postamble is missed.

4.2.3.11 Circuit CG — Signal Quality Detector (SQ) (OC)

Direction: To the STU-III BDI

Signals on this circuit are used to indicate whether or not there is a high probability of an error in the received data.

An ON condition persists whenever there is no reason to believe an error has occurred.

An OFF condition indicates that there is a high probability of error. As an option, it may be used to invoke the fade bridging strategies (see Section 4.3.6.2.3.1).

4.2.3.12 Circuit CH — Data Signal Rate Selector (DTE Source) (OC)

Direction: From the STU-III BDI

Signals on this Circuit are used to select between two data signaling rates. Since the STU-III BDI may support more than two rates, a method of assigning two rates to Circuit CH is needed. A STU-III BDI that supports more than two rates shall provide the user with the capability to assign two data rates to the two states of Circuit CH. For applications where the digital interface line rate cannot change, the user shall be able to disable Circuit CH line rate control. (In this case the terminal must rate adapt, in response to a rate change request. See Section 4.3.6.2.5 for more on rate adaption and rate changes.) Use of Circuit CH is an Optional

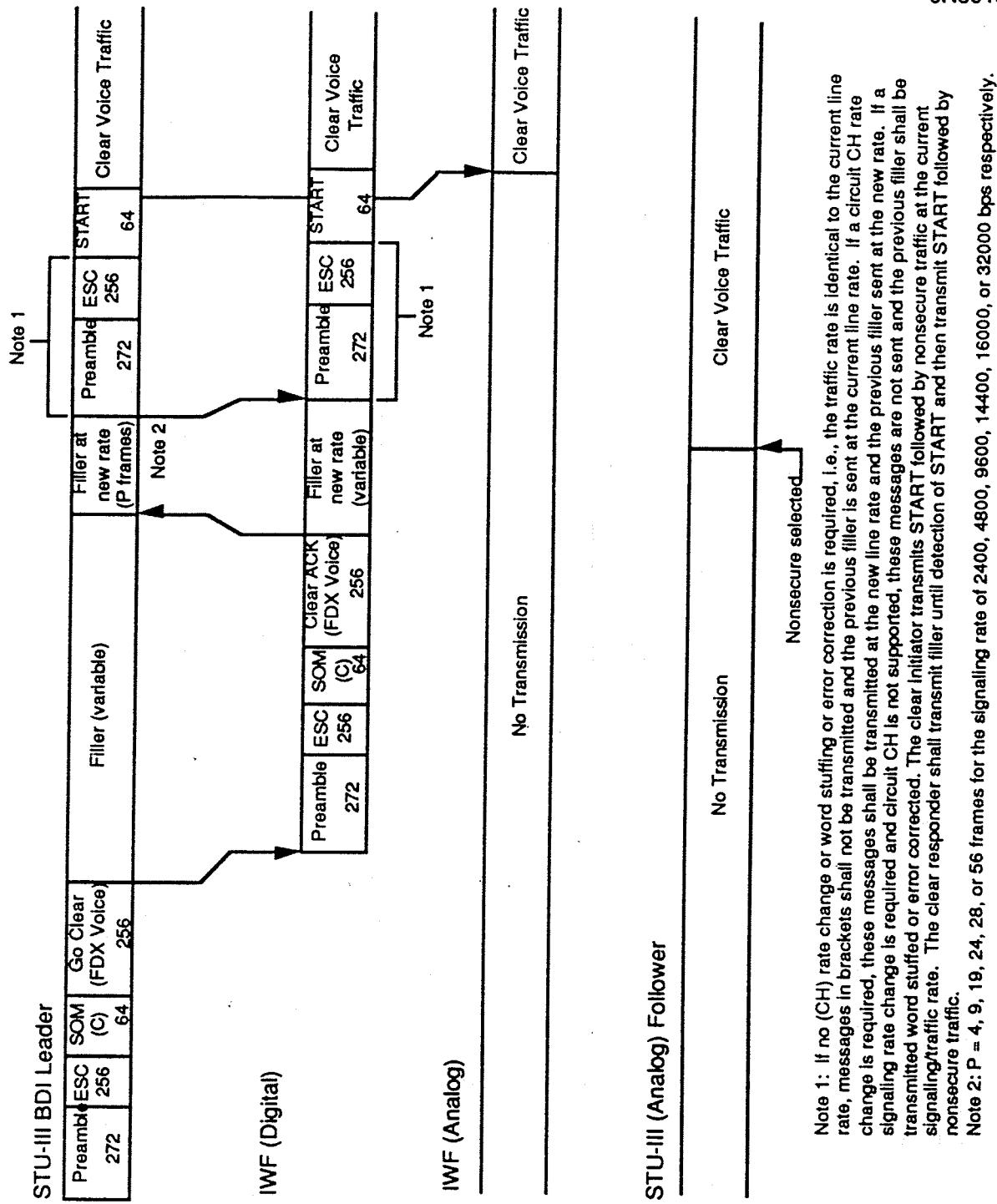


Figure 5.1.1.3.6-1 (b) IWF Full-Duplex Failed Call Signaling for a STU-III BDI Full-Duplex Leader (Cont.)

Capability, but rate adaption for secure fallback to 2400 bps operation shall be supported in any STU-III BDI providing higher line rates. An ON condition shall select the higher line rate.

4.2.3.13 Circuit DA — Transmitter Signal Element Timing (TXC-DTE Source) (OC)

Direction: From the STU-III BDI

Signals on this circuit are used to provide the DCE with signal element timing information. This circuit shall be active only when the BDI terminal is configured to provide transmit timing.

The ON to OFF transition shall nominally indicate the center of each signal element on Circuit BA. When Circuit DA is strapped on, (i.e. the BDI terminal is configured to provide transmit timing), the STU-III BDI shall provide timing information on this circuit whenever it is in a Power On condition.

4.2.3.14 Circuit DB - Transmitter Signal Element Timing (TXC-DCE Source) (MER)

Direction To the STU-III BDI

Signals on this circuit are used to provide the STU-III BDI with signal element timing, provided that the BDI terminal is configured to accept transmit timing. The STU-III BDI shall provide a data signal on Circuit BA in which the transitions between signal elements nominally occur at the time of the transitions from the OFF to ON condition of the signals on Circuit DB. The STU-III BDI shall permit the DCE to withhold timing information for short periods provided that Circuit CC is in the OFF condition.

4.2.3.15 Circuit DD - Receiver Signal Element Timing (RXC-DCE Source) (MER)

Direction: To the STU-III BDI

Signals on this circuit shall be used to provide the STU-III BDI with received signal element timing information. The transition from the ON to OFF condition shall nominally indicate the center of each signal element on Circuit BB. This circuit will be active at all times when circuit CF is in the ON condition. The STU-III BDI must be operable whether or not signals on this circuit are present after the transition from the ON to OFF condition of circuit CF.

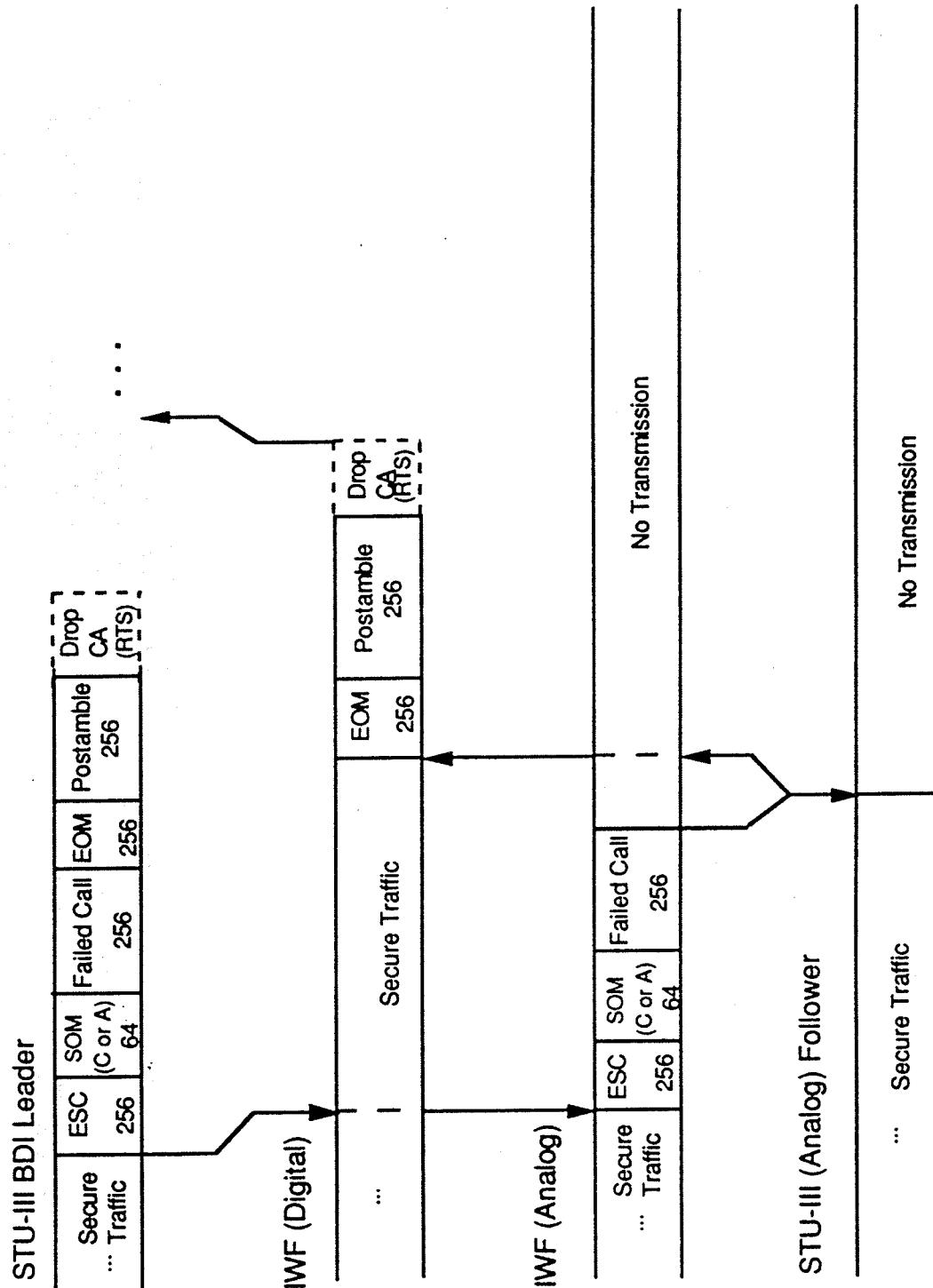


Figure 5.1.13.6-1 (a) IWF Full-Duplex Failed Call Signaling for a STU-III BDI Full-Duplex Leader

4.2.4 Electrical Circuit Protocol (MER)

This section specifies the required interactions among the various EIA/TIA-232-E circuits and some of the messaging supported by these circuits. Note that it is intended to illustrate the sequence of EIA/TIA-232-E circuit changes that are required to transition the BDI from a given initial state to a new state, and therefore does not necessarily represent all the circuit transitions required to transition the STU-III BDI from the idle mode to clear or secure traffic.

In the following state transition diagrams, the circuit states of the mandatory control circuits are shown in a compact, octal notation (X,Y), where the X element of the duple is the Group A octal code and the Y element is the Group B code. Group A and Group B codes are defined in Table 4.2.4-1.

Group A				Group B		
CC	CD	CE		CA	CB	CF
DCE Ready	DTE Ready	Ring Indicator	Octal Code	Request to Send	Clear to Send	Received Line Signal Detector
0	0	0	0	0	0	0
0	0	1	1	0	0	1
0	1	0	2	0	1	0
0	1	1	3	0	1	1
1	0	0	4	1	0	0
1	0	1	5	1	0	1
1	1	0	6	1	1	0
1	1	1	7	1	1	1

Table 4.2.4-1 Circuit State Octal Codes

5.1.1.3.6 Signaling for Failed Call (MER)

Failed call signaling for two Full-Duplex STU-III BDI terminals is specified in Section 4.3.6.2.1.3.2. With the IWF, a straightforward analog/digital mapping of the Failed Call sequence is followed by a Go Clear Voice mode setup exchange on the digital side. Failed Call signaling begins when the Leader terminates secure traffic using an EOM sequence with the Failed Call message. The Follower's secure traffic ends upon detection of the Leader's Failed Call message or loss of carrier. If the analog side terminal leads the failed call, the digital side Follower shall send an EOM followed by Postamble and then shall drop carrier. If the digital side terminal leads, the analog side Follower drops carrier immediately. The IWF shall then engage in the Clear Voice setup exchange on the digital side only. Clear mode traffic shall be disabled until the user has activated the terminal's nonsecure control. Figure 5.1.1.3.6-1 illustrates the FDX Failed Call processing for a STU-III BDI Leader. Figure 5.1.1.3.6-2 illustrates the FDX Failed Call processing for a STU-III BDI Follower.

Failed call signaling for two Half-Duplex STU-III BDI terminals is specified in Section 4.3.6.2.2.2.2. Half-duplex Failed Call signaling with an IWF begins when the Leader terminal detects a failure condition and terminates secure traffic by transmitting Preamble, Escape, SOM (C or A), Failed Call, EOM, EOM and Postamble (if a STU-III BDI), or P1800, SCR1, SOM (C or A), Failed Call and EOM (if an Analog STU-III). A half-duplex clear voice call setup will then be initiated. Figure 5.1.1.3.6-3 illustrates the Failed Call processing for the half-duplex STU-III BDI Leader. Figure 5.1.1.3.6-4 illustrates the Failed Call processing for the half-duplex STU-III BDI Follower.

4.2.4.1 Dedicated Full-Duplex Service Protocols

4.2.4.1.1 Dedicated Full-Duplex Engage Service, Originator (MER)

The state diagram in Figure 4.2.4.1.1-1 shows a state (2,0) in which the DCE power is off. Transmission cannot be provided in this state. The normal idling state of the BDI is indicated by (6,0); it is entered when the DCE is powered on. In this state, transmission can be provided.

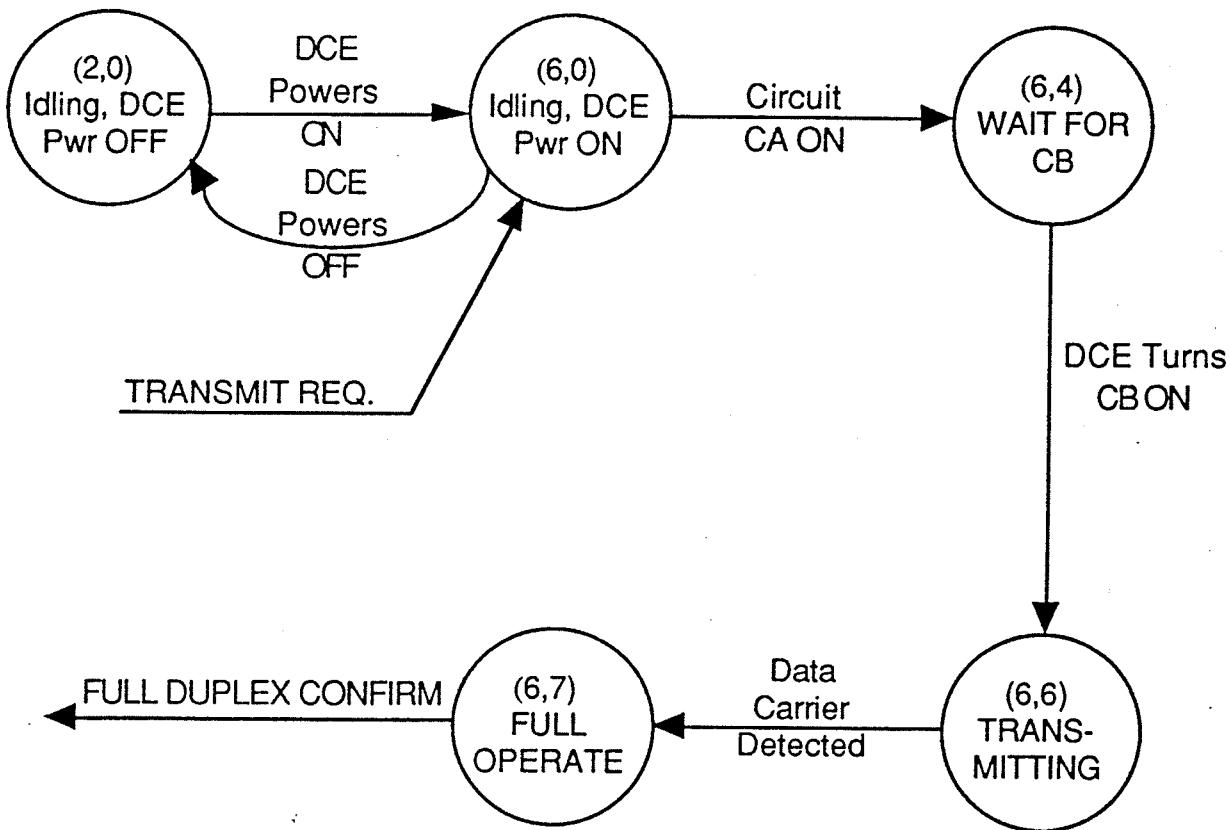


Figure 4.2.4.1.1-1 EIA/TIA-232 Interface State Diagram, Dedicated Full-Duplex Engage Service, Originator

When transmission is desired, the BDI shall turn Circuit CA, Request to Send, ON. The DCE will now respond by turning on its transmitter and sending training signals across the transmission medium to its peer DCE. When a circuit has been established between the two peers, the Originator's DCE will set Circuit CB to the ON condition so that the circuit state transitions to (6,6). (Some implementations may wish to time this transition and provide a failure indication if it appears that the state transition has not taken place in a reasonable period.)

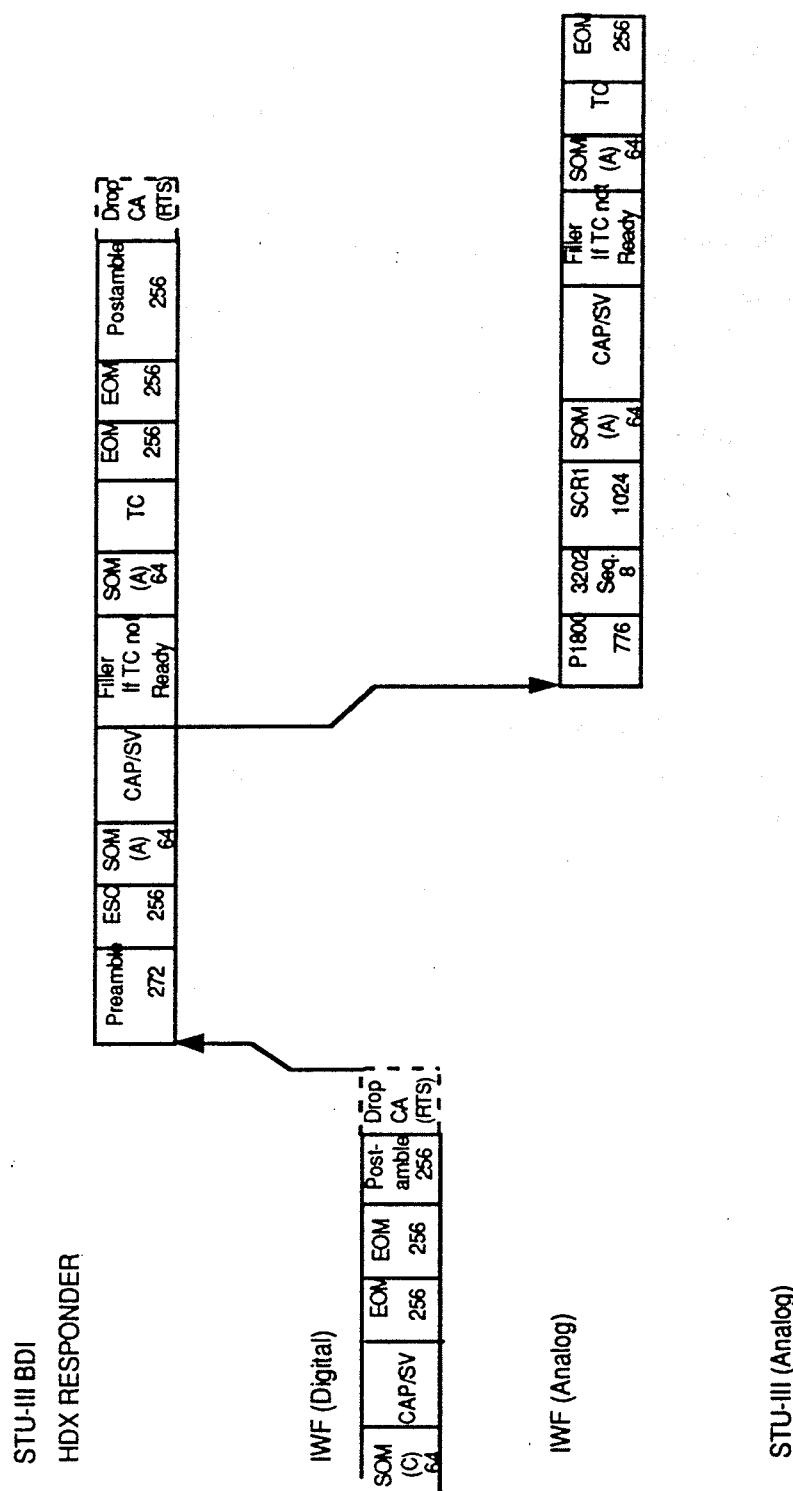


Figure 5.1.1.3.5-2 (b) IWF Full-Duplex to Half-Duplex Transition for a STU-III BDI Full-Duplex Initiator (Cont.)

If there is a peer BDI that is properly connected, it will "hear" the transmission occasioned by entry into state (6,6) and begin transmitting on its own (full-duplex operation). This diagram assumes that a Responding STU-III BDI is connected to the transmission medium and is turned on. In the normal course of events, a Responder will turn on its transmitter. (See Figure 4.2.4.1.2-1 for a state diagram of a Responder). Its transmission will be detected by the originating DCE that will, in turn, respond by placing circuit CF, Data Carrier Detect, in the ON state. This will cause the state to transition to (6,7), the Full Operate state.

4.2.4.1.2 Dedicated Full-Duplex Engage Service, Responder (MER)

Figure 4.2.4.1.2-1, below, is the companion to Figure 4.2.4.1.1-1. This Figure illustrates the state changes that an answering dedicated terminal's BDI transitions through when it is connected to a peer that behaves according to Figure 4.2.4.1.1-1.

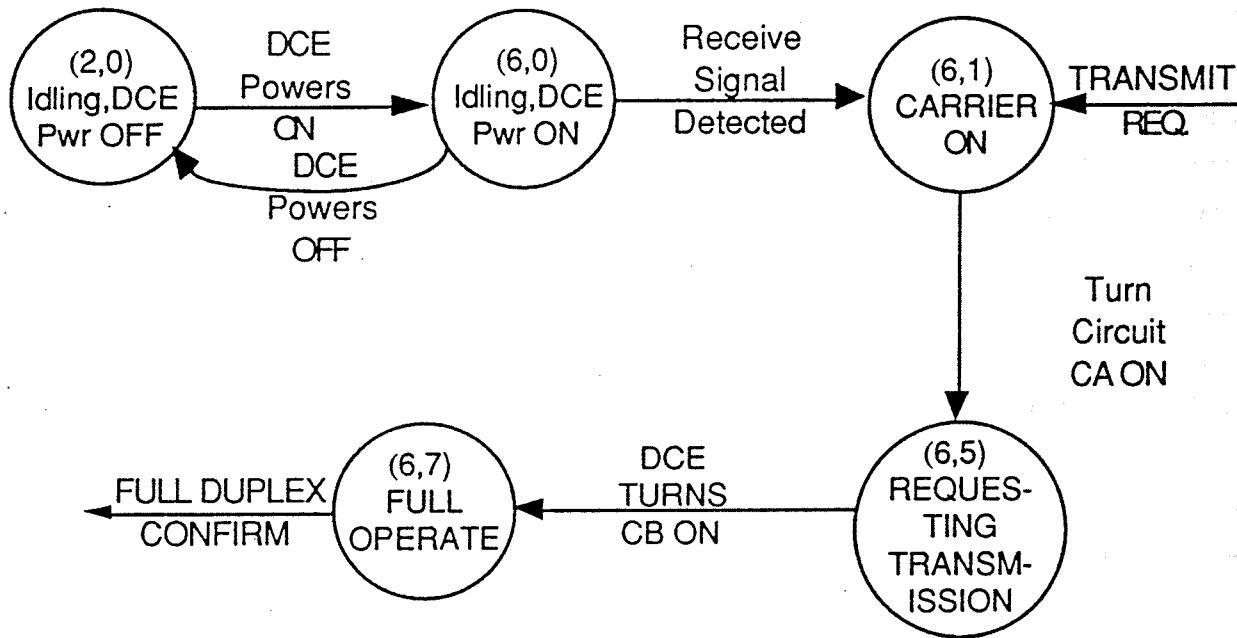


Figure 4.2.4.1.2-1 EIA/TIA-232 Interface State Diagram, Dedicated Full-Duplex Engage Service, Responder

If the DCE is powered on, the Responder knows that it is being contacted when its DCE detects a signal transmitted from the Originator. The DCE will turn Circuit CF ON, and the BDI shall transition to state (6,1). The first message received in this state will be the Ring/Y alert (see

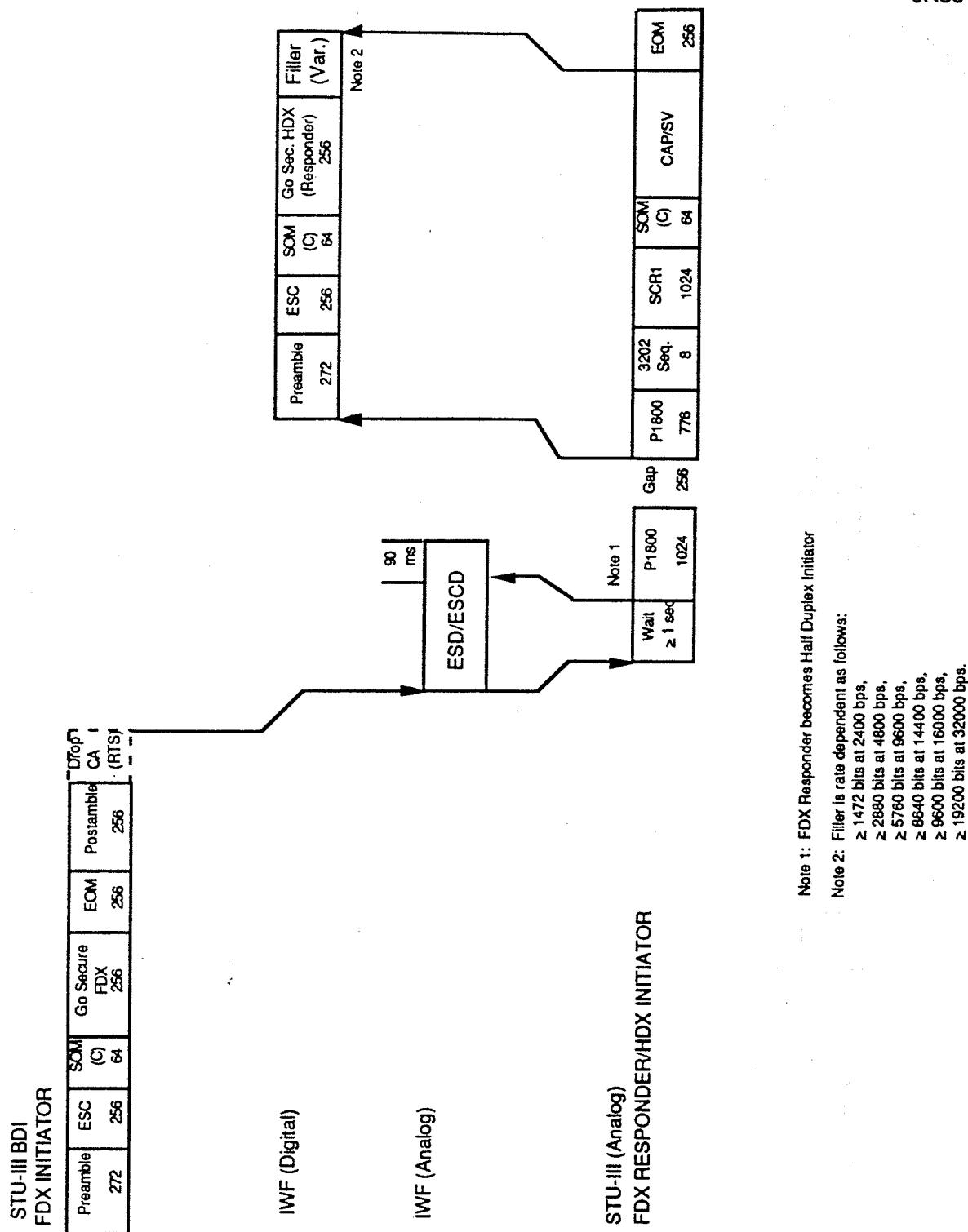


Figure 5.1.1.3.5-2 (a) IWF Full-Duplex to Half-Duplex Transition for a STU-III BDI Full-Duplex Initiator

Section 4.3.5.1). The Core STU may audibly alert (ring) until the user picks up the handset, or until timeout occurs.

The user going off-hook will result in a transmission request to the BDI. The BDI shall respond by turning Circuit CA ON, so that state (6,5) is entered. Once the path from the Responder to the Originator is established, the DCE will turn Circuit CB ON so that state (6,7) shall be entered. As the BDI enters the Full Operate state, the signal generated will be detected by the originating side causing the Originator's BDI to generate the confirmation as described above.

4.2.4.1.3 Dedicated Full-Duplex Disengage Service (MER)

Figure 4.2.4.1.3-1 illustrates the transition from the Full Operate state when the Core STU requests that the BDI disengage service. (Requesting this service in most other states is an error. The exception will be addressed below.)

The BDI's response to a disengage request shall be to turn circuit CA, Request to Send, OFF. The response of the DCE will be to turn circuit CB, Clear to Send, OFF and transmit all buffered data so that state (6,1) is entered.

The entry to state (6,1) will remove the signal from the transmission medium. The far-end terminal should respond in kind and remove its own signal. This loss of signal will be detected by the DCE, which will then turn Circuit CF, Received Line Signal Detector, OFF, so that state (6,0) is entered. The BDI shall then issue an end of transmission confirmation to the Core STU. The diagram also shows a final state caused by removal of DCE power, though this is not necessarily a part of the disengage service.

The exception to the rule that the BDI should not be disengaged except when it is in the Full Operate state occurs when the Originator is unable to complete a connection with a Responder. The BDI will be left in the (6,6) transmitting state long enough for it to return a negative confirmation to the core STU. At this point, the Core STU should request disengage service to clear the line. Figure 4.2.4.1.3-2 illustrates this function.

In this case, the BDI shall issue the confirmation on entry into the same state, (6,0), even though there was no action on the part of a Responder to cause entry into that state.

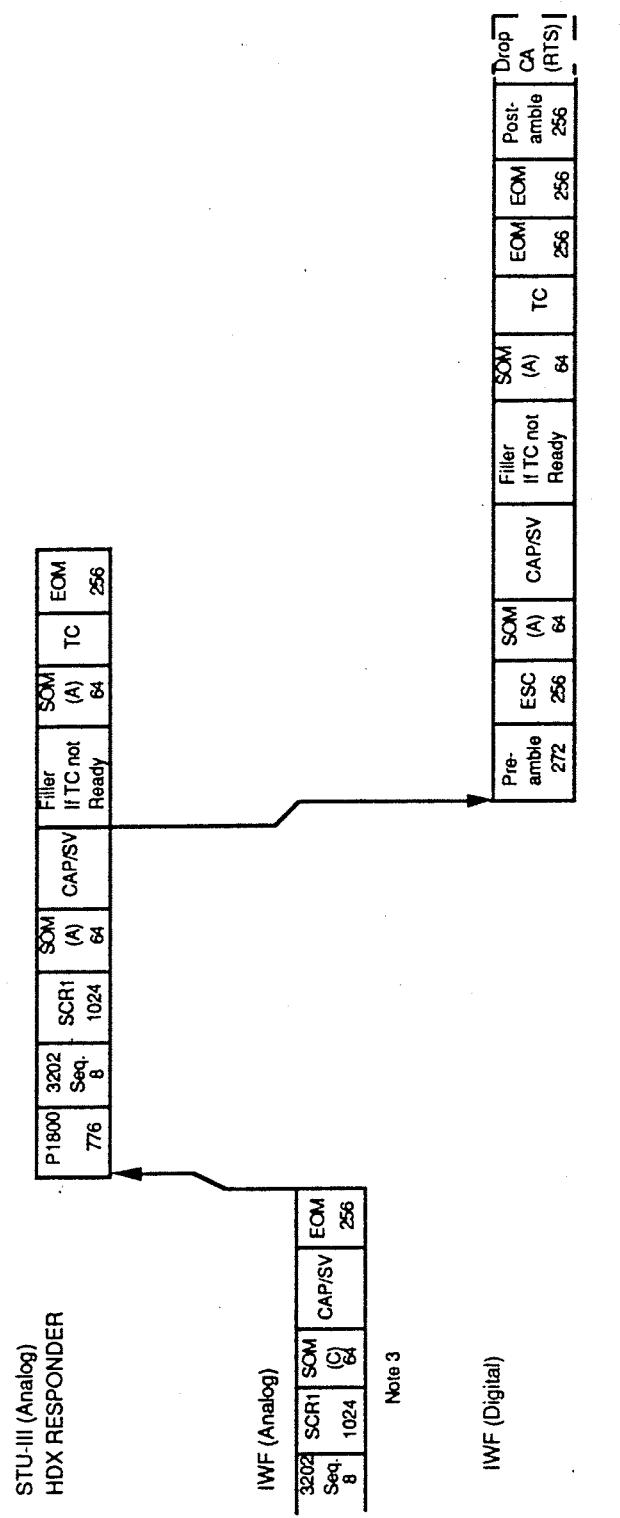


Figure 5.1.1.3.5-1 (b) IWF Full-Duplex to Half-Duplex Transition for a STU-III Full-Duplex Initiator (Cont.)

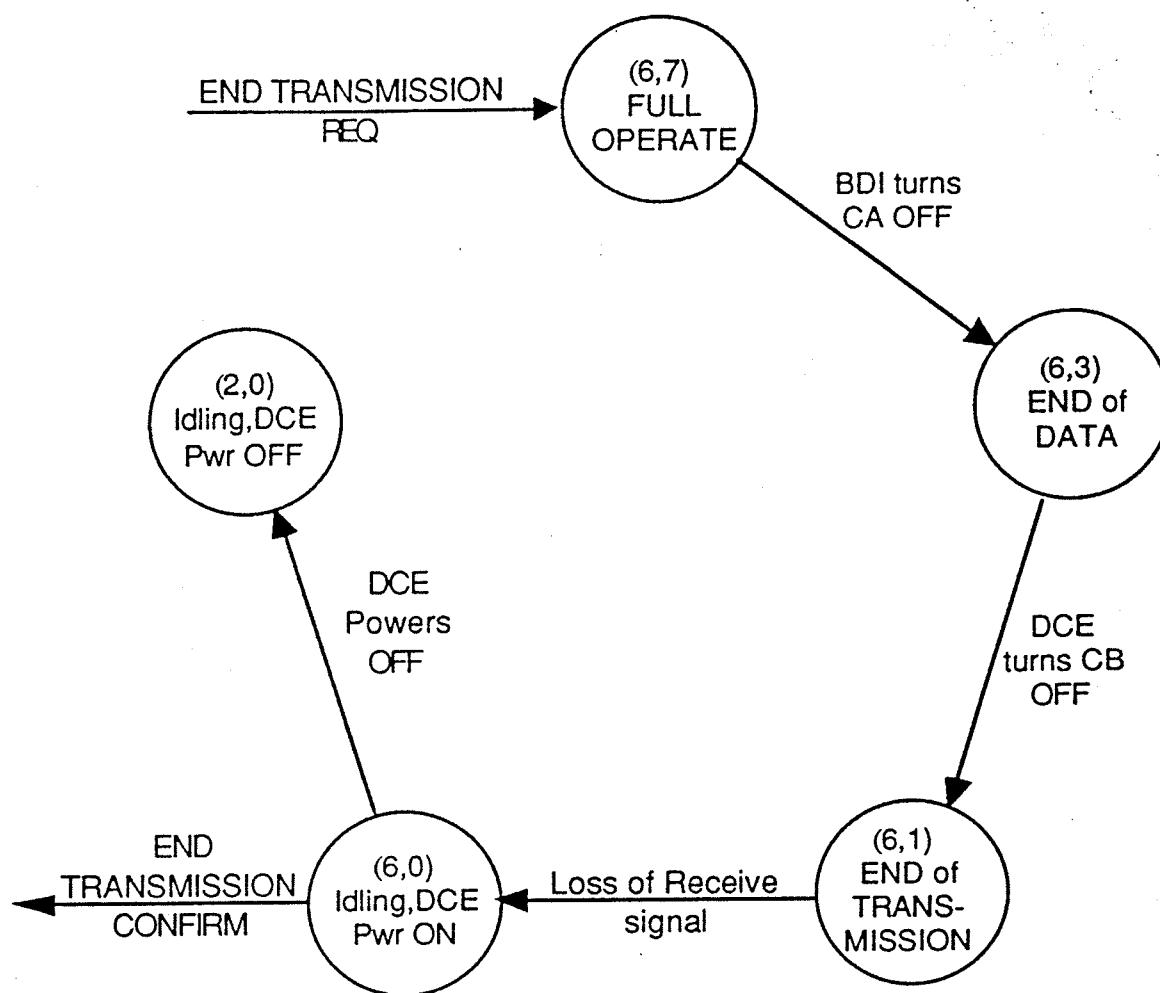


Figure 4.2.4.1.3-1 EIA/TIA-232 Interface State Diagram, Dedicated Full-Duplex Disengage Service

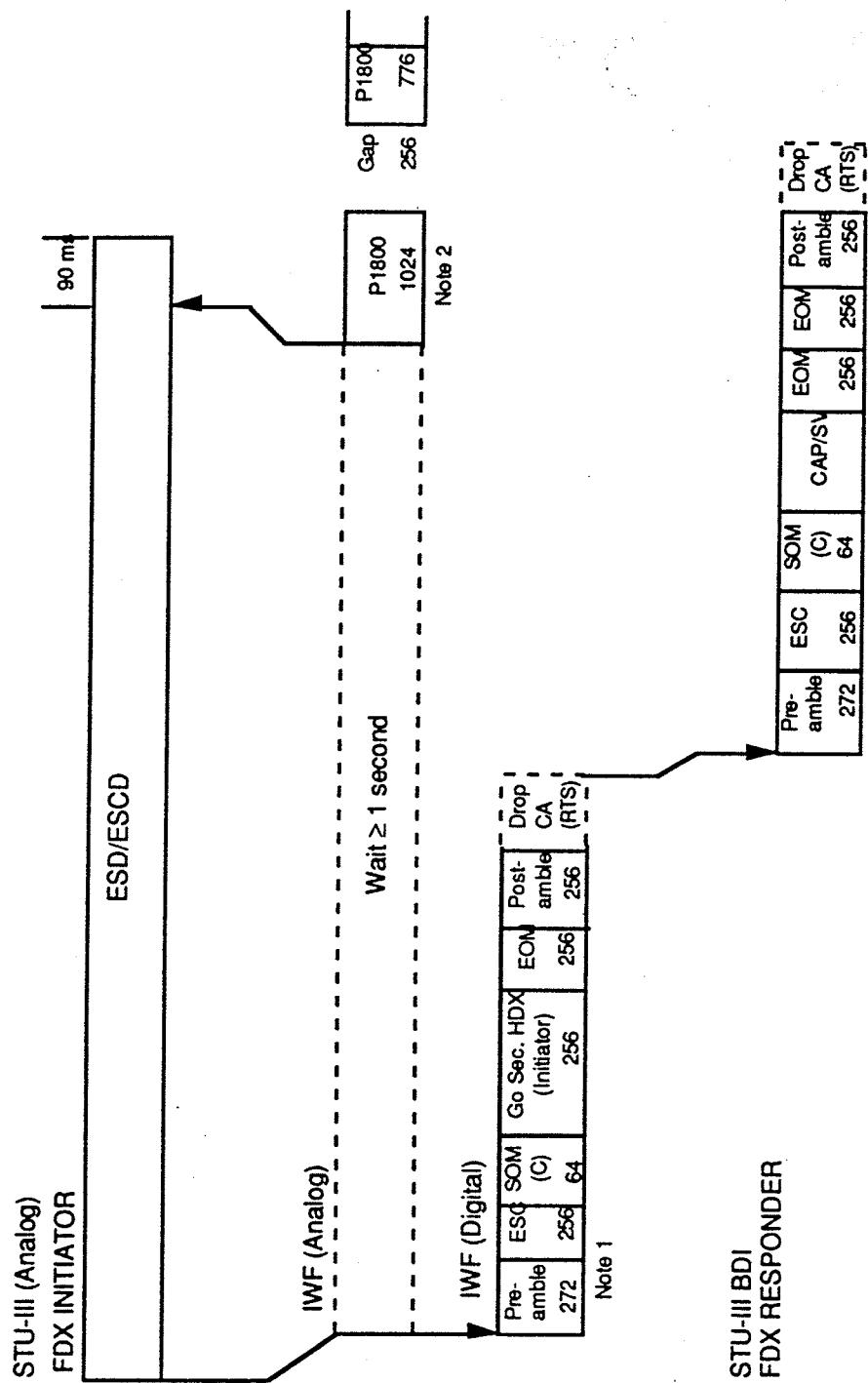


Figure 5.1.1.3.5-1 (a) IWF Full-Duplex to Half-Duplex Transition for a STU-III Full-Duplex Initiator

Note 1: The STU-III BDI has pre-staged the IWF to half duplex.
This allows the turnaround to occur without waiting for digital delays.

Note 2: FDX Responder becomes Half-Duplex Initiator. IWF transmits P1800/Gap without waiting for CAP/SV from the STU-III BDI.

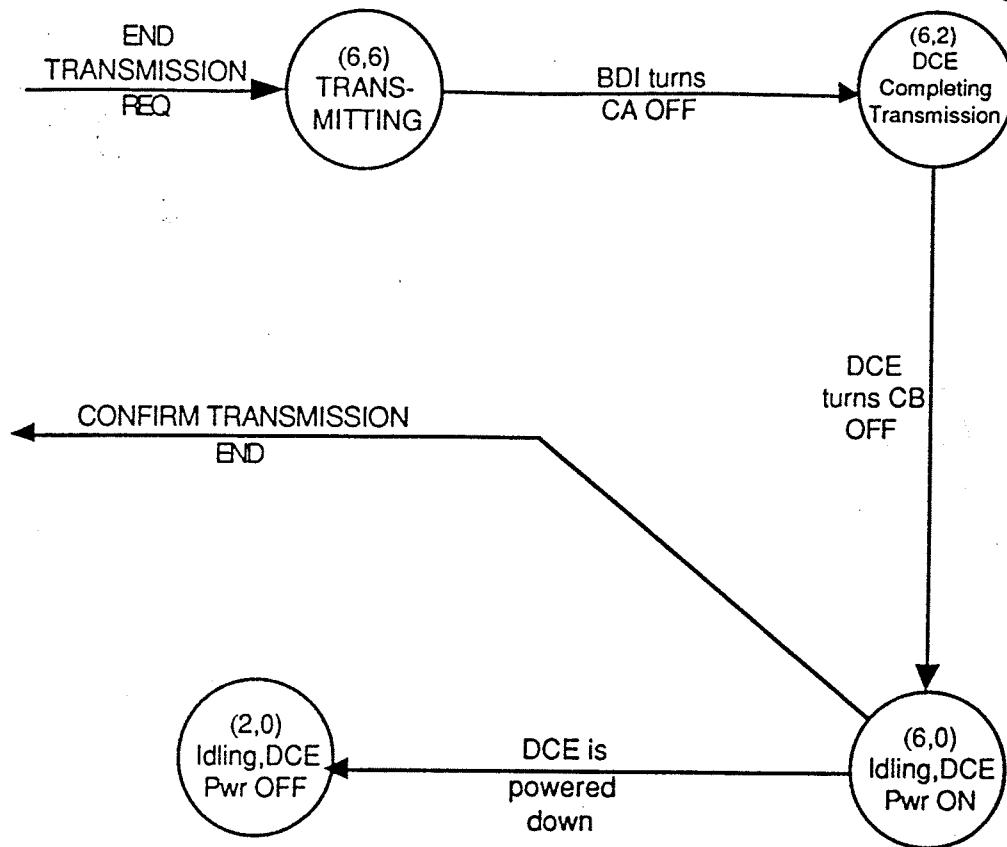


Figure 4.2.4.1.3-2 EIA/TIA-232 Interface State Diagram Dedicated Initiator Disengage Request, Circuit CF OFF

4.2.4.1.4 Dedicated Full-Duplex Service, Loss of Signal Indication (MER)

Figure 4.2.4.1.4-1 illustrates the response of the BDI to loss of receive signal by the DCE. This illustration appears more complex than others due to the requirement that the BDI participate in an attempt to bridge fades. Fades may be characterized in several ways. They may be defined as periods of short duration in which the bit-error rate (BER) is extraordinarily high, or they may be periods in which the signal does not meet the criteria of the DCE's received signal detector. In the latter case, the DCE will turn Circuit CF OFF. If the DCE is equipped with Circuit CG, Signal Quality Detector, it will turn that Circuit OFF while keeping Circuit CF ON. Figure 4.2.4.1.4-1 shows the simplest case, the DCE turning Circuit CF OFF. For fade bridging to work, the DCE's Receiver Signal Element Timing, Circuit DD, must be present throughout the duration of the fade.

Next, the STU-III BDI sends a variable amount of *Filler* until the TC is ready for transmission. In the meantime, the IWF shall generate Scrambled Ones to train the STU-III equalizer. The remainder of call setup for this example is straightforward. Figure 5.1.1.3.5-1 illustrates the mapping for the scenario in which the STU-III BDI is the half-duplex Initiator.

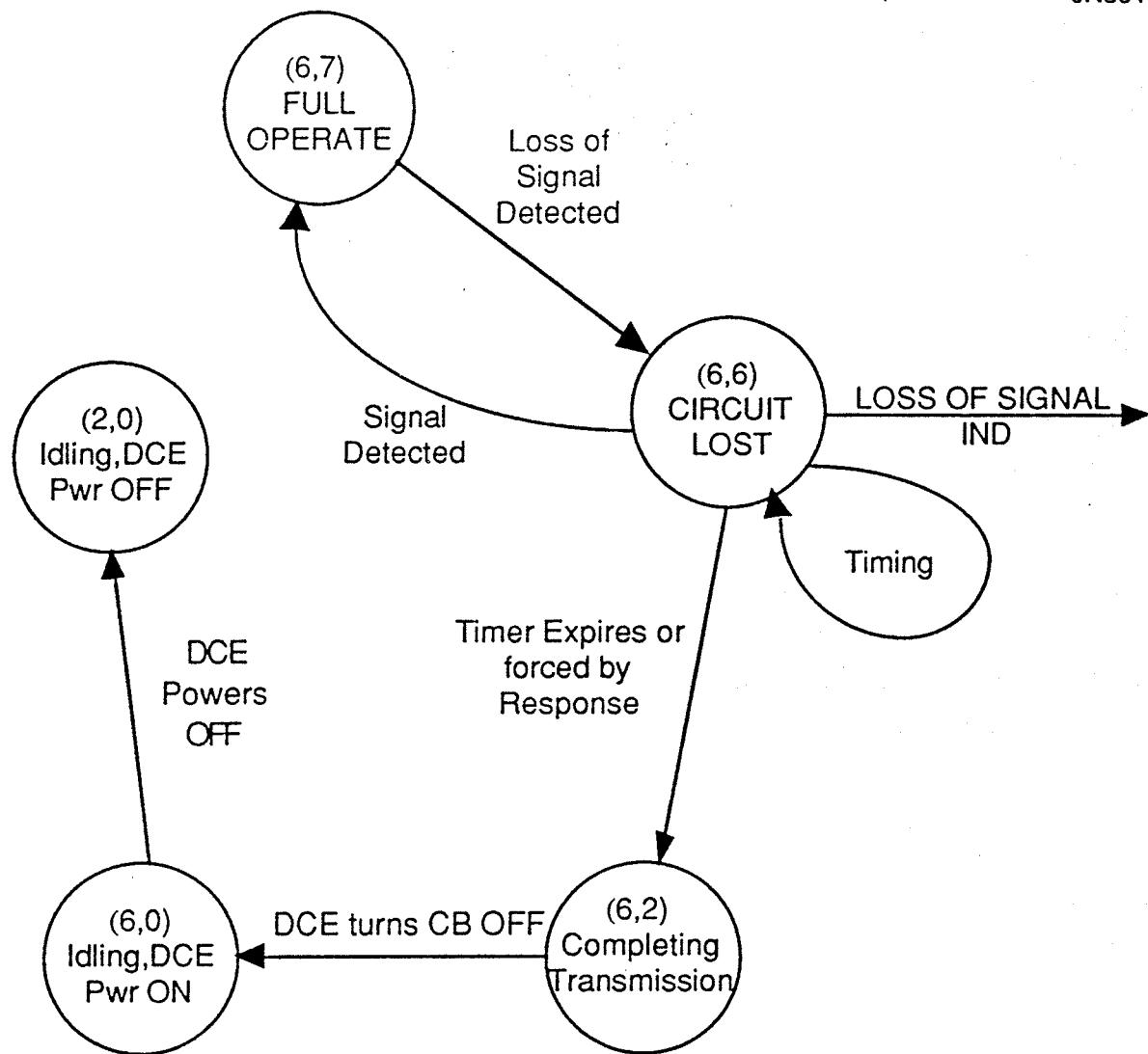


Figure 4.2.4.1.4-1 EIA/TIA-232 Interface State Diagram, Dedicated Full-Duplex Loss of Receive Signal

When the DCE detects loss of signal, it turns Circuit CF OFF so that state (6,6) is entered. At this point a timer shall be started. This timer shall have either an operator selectable period, or if the period is not selectable, the timer shall have a duration of 10 seconds. Entry into this state shall also cause the issuance of a loss of signal indication to the Core STU.

If the Core STU decides to disengage service (a determination of higher-level functions), it shall respond with an end of transmission command. This will force quick entry into the (6,0) idle state. The Core STU may not request a disengagement and therefore may remain idle.

5.1.1.3.5 Signaling for Full-Duplex to Half-Duplex Mode Change (MER)

When an analog STU-III or a STU-III BDI initiates a full-duplex secure call setup and the Responder is set for the half-duplex mode, the Responder will force both terminals to a half-duplex mode of operation by responding with half-duplex Initiator signaling. Figures 5.1.1.3.5-1 and 5.1.1.3.5-2 illustrate the protocol when an Interworking Function is involved. If the full-duplex Responder forces the transition, it becomes the half-duplex Initiator, and the full-duplex Initiator becomes the half-duplex Responder.

The analog STU-III begins signaling as the full-duplex Initiator by sending the ESD/ESCD tone, as shown in Figure 5.1.1.3.5-1. The IWF, which has been pre-staged for half-duplex, shall translate this into the BDI message sequence Preamble, ESC, SOM(C), *Go Secure HDX (Initiator)*, EOM, and Postamble. The IWF shall also transmit Pseudo 1800 Hz with a gap to the analog STU-III. Once the STU-III BDI transmits the Preamble/ESC/SOM(C) and CAP/SV messages, it becomes the half-duplex Initiator, using GPC scrambling for subsequent signaling. Note that if there is a long delay on the digital side and modem training has been completed, the IWF shall transmit SCR1 (V.26), B1 (V.32), or filler (V.26 or V.32) in complete 64-bit increments, until the CAP/SV is received. When the STU-III receives the P1800 with gap, it becomes the half-duplex Responder, using SOM(A) and GPA scrambling. After the new roles are established, signaling occurs as in normal half-duplex secure call setup.

Figure 5.1.1.3.5-2 shows a similar situation with the STU-III BDI as the full-duplex Initiator becoming the half-duplex Responder. In this case, the STU-III forces the transition and thus becomes the half-duplex Initiator.

With full-duplex secure call initiation removed, the two examples of this section specify the Interworking Function mapping for a typical half-duplex secure call setup. In Figure 5.1.1.3.5-2, the STU-III is the half-duplex Initiator. The IWF shall map the analog STU-III signals to the digital STU-III BDI format and vice versa. The HDX Initiator's analog Pseudo 1800 Hz signal with gap is converted to the digital *Go Secure Half-Duplex* preceded by a *Preamble*, *Escape*, and *SOM(C)*. Scrambled Ones are used to train the Interworking Function equalizer for the analog channel; a variable length *Filler* message is inserted on the digital side.

The Interworking Function receives the STU-III BDI half-duplex sequence of *Preamble*, *Escape*, *SOM(A)* and *CAP/SV* and shall transmit the Pseudo 1800 Hz signal to the STU-III.

Before the timer expires, the BDI shall allow reentry to state (6,7), full operate. If this state is re-achieved, the BDI shall issue an indication to notify the Core STU of the circuit recovery. If the timer expires, the BDI shall continue to shut down to the idle state (6,0). This will clear the DCE off the line to allow later reuse.

4.2.4.2 Dedicated Half-Duplex Service Protocols

4.2.4.2.1 Dedicated Half-Duplex Engage Service, Transmit (MER)

Figure 4.2.4.2.1-1 illustrates the state changes of the BDI when the Core STU requests half-duplex transmit. Half-duplex protocols only allow this state to be entered from the idle state with DCE power on.

When transmission is desired, the BDI shall turn Circuit CA ON. The DCE will now respond by turning on its transmitter and establishing a connection with its peer DCE. When a connection has been established, the originating DCE will set Circuit CB to the ON condition so that state (6,6) is entered. This is the half-duplex transmit state.

4.2.4.2.2 Dedicated Half-Duplex Engage Service, Receive (MER)

Figure 4.2.4.2.2-1 illustrates the state changes of the BDI when it detects a signal received from the far-end terminal in half-duplex mode. As above, half-duplex protocols only allow this state to be entered from the idle state with DCE power on.

A STU-III BDI configured for half-duplex operation and in the idle state shall constantly monitor for receive signal. When the local DCE detects a receive signal, it will turn Circuit CF, Received Line Signal Detector, ON. This shall cause the BDI to transition to the (6,1) state, half-duplex receive, and provide an indication to the Core STU. The BDI shall remain in this state until Circuit CF is turned OFF or the operator intervenes.

4.2.4.2.3 Dedicated Half-Duplex Disengage Service (MER)

A Core STU may request disengagement while the BDI is operating in half-duplex mode. The state diagram for the Initiator of the disengagement is shown in Figure 4.2.4.2.3-1.

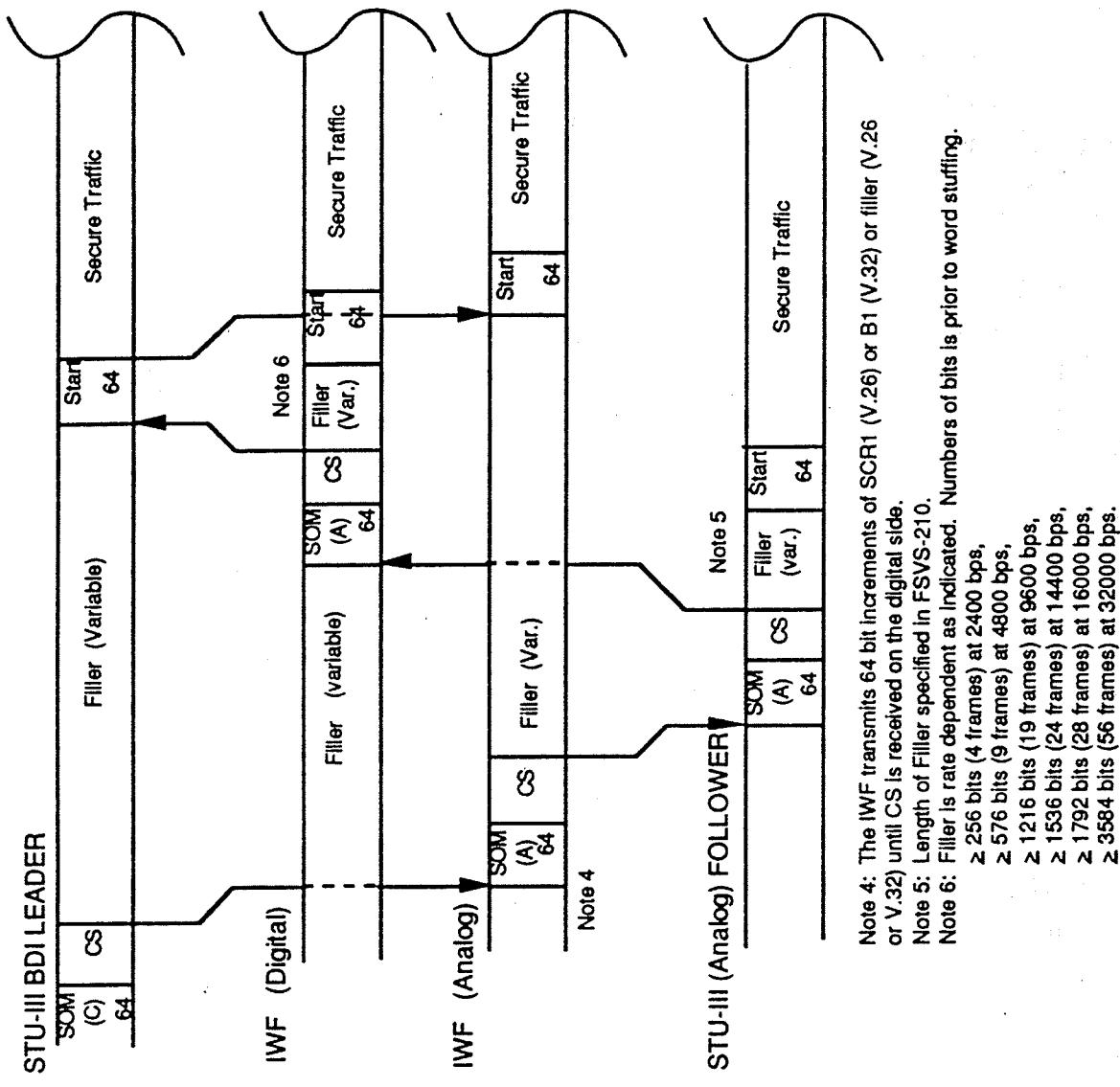


Figure 5.1.1.3.4-2 (c) IWF Full-Duplex Retrain Signaling for a STU-III Follower (Cont.)

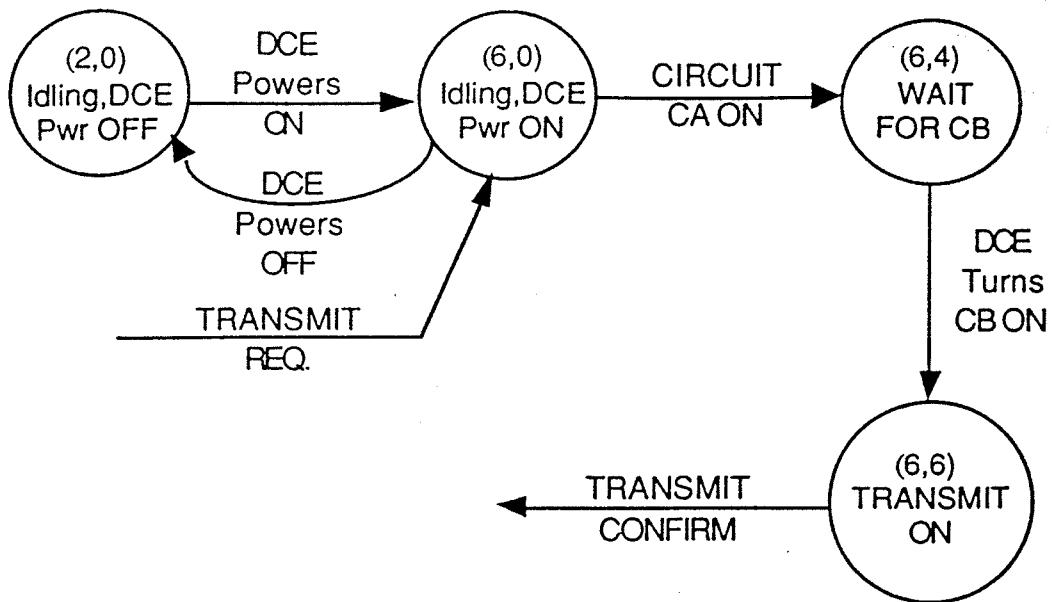


Figure 4.2.4.2.1-1 EIA/TIA-232 Interface State Diagram, Dedicated Half-Duplex Engage Service, Transmit

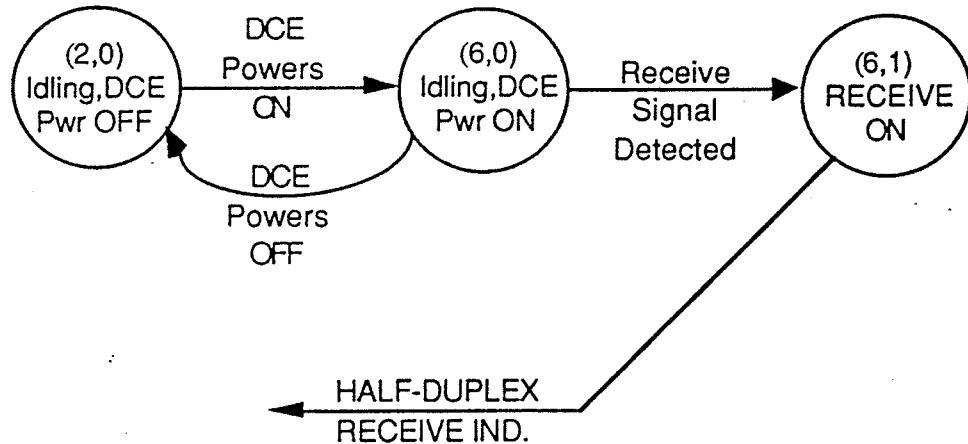


Figure 4.2.4.2.2-1 EIA/TIA-232 Interface State Diagram, Dedicated Half-Duplex Engage Service, Receive

In this case, the Core STU issues the disengagement request while the BDI is in the (6,6) transmitting state. (It should be issued after all the data of the last transmission has been sent, but this is part of a function above the BDI.) The BDI shall turn off Circuit CA, and the DCE should follow by turning off Circuit CB.

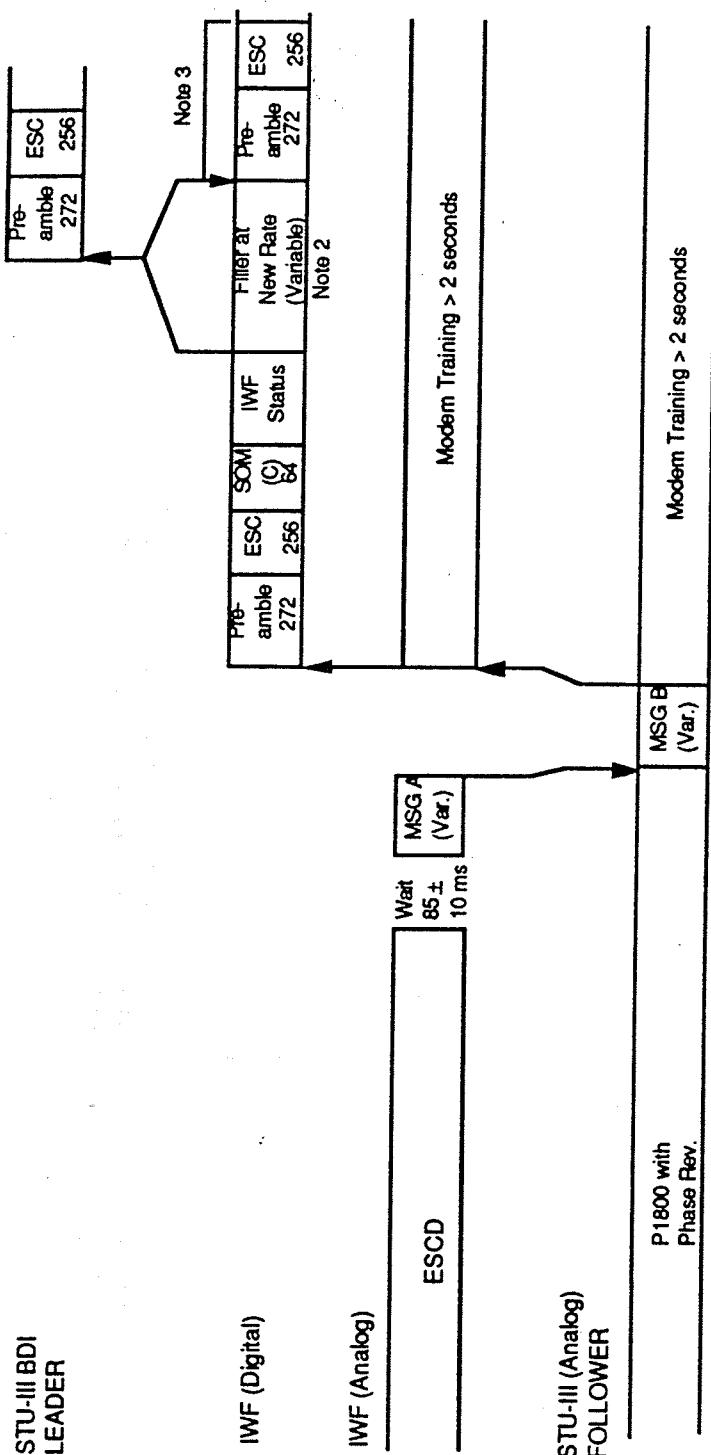


Figure 5.1.1.3.4-2 (b) IWF Full-Duplex Retrain Signaling for a STU-III Follower (Cont.)

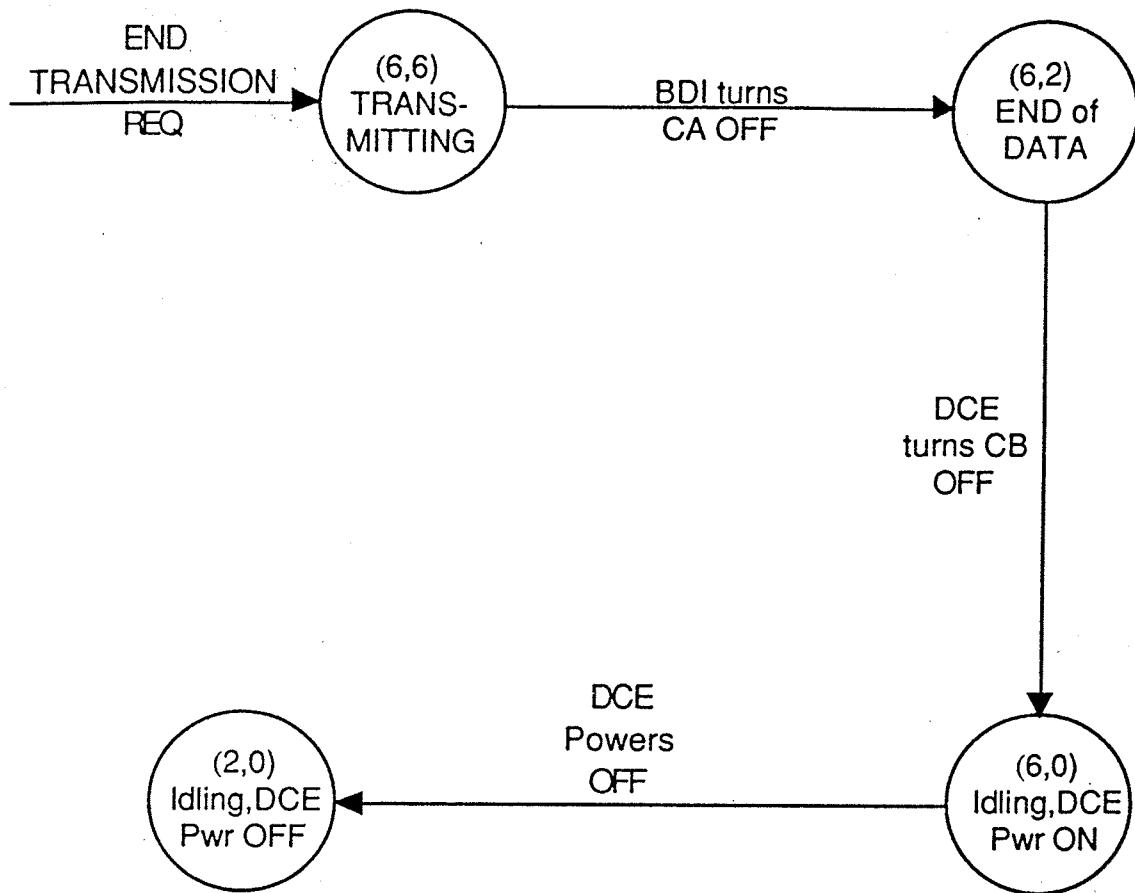


Figure 4.2.4.2.3-1 EIA/TIA-232 Interface State Diagram, Dedicated Disengage in Half-Duplex Mode

No equivalent diagram is shown for the responding side. If the responding side makes the last transmission (according to a higher level protocol), the sequence of events shall be the same as above. The responding side shall simply do nothing (at the BDI level) if it does not make the last transmission.

4.2.4.3 Dedicated Mode Change From Full to Half-Duplex (MER)

Figure 4.2.4.3-1 illustrates a mode change from full to half-duplex. The half-duplex request occurs with the BDI in the full-duplex, full operate state (6,7).

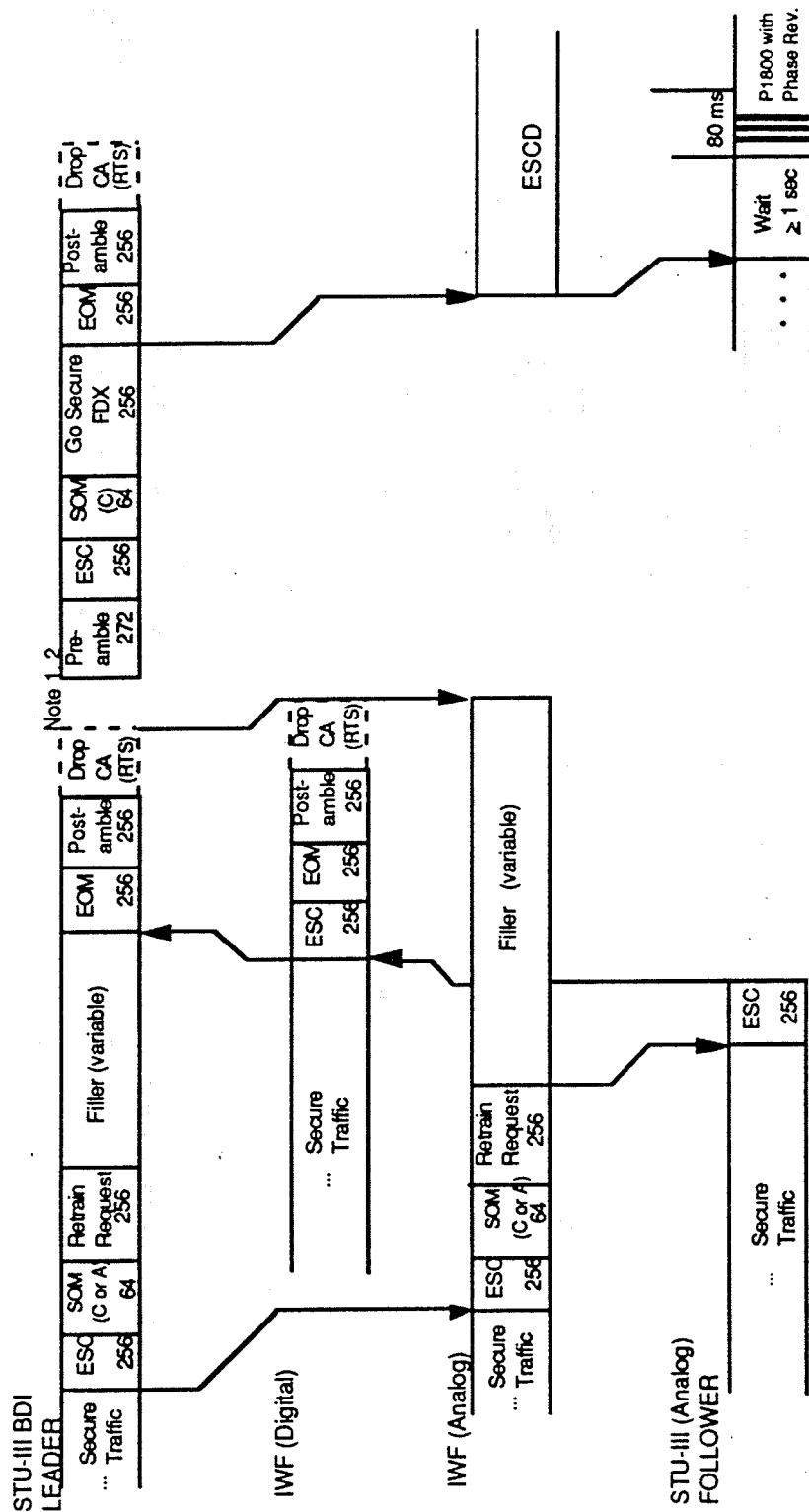


Figure 5.1.1.3.4-2 (a) IWF Full-Duplex Retrain Signaling for a STU-III Follower

Two state diagrams are shown in the figure. Preceding the action there must be (at a higher level) agreement between the two STUs that such a change shall take place. One of these STUs will request such a change of the BDI first. It will know it is first because it will not have received any service calls from the BDI subsequent to the agreement. It will request half-duplex operation.

The response of the BDI shall be to turn Circuit CA off. The DCE should follow suit and turn Circuit CB off. Finally the other STU should stop transmitting, which should be detected by the DCE, and so state (6,0) should be entered. The BDI shall then respond with a half-duplex confirmation.

The STU that is slower to respond to the agreement will not be able to issue a service request before the DCE detects a loss of signal. The DCE will turn Circuit CF off so that the BDI shall enter state (6,6). The BDI does not "know" that it is to enter a two-way alternate (half-duplex) mode, and so it shall issue a loss of signal indication.

The Core STU should be expecting this indication (because of the higher level agreement), so it should respond with a half-duplex request. Note that the subsequent action of the BDI and DCE is (shall be) identical to the response to a disengage. The idle state (6,0) will be reached.

4.2.4.4 Dedicated Service, Mode Change From Half to Full-Duplex (MER)

The mode change complementing that described above is from half-duplex to full-duplex. As in the case above, agreement between the STUs at a higher level must precede the actions described.

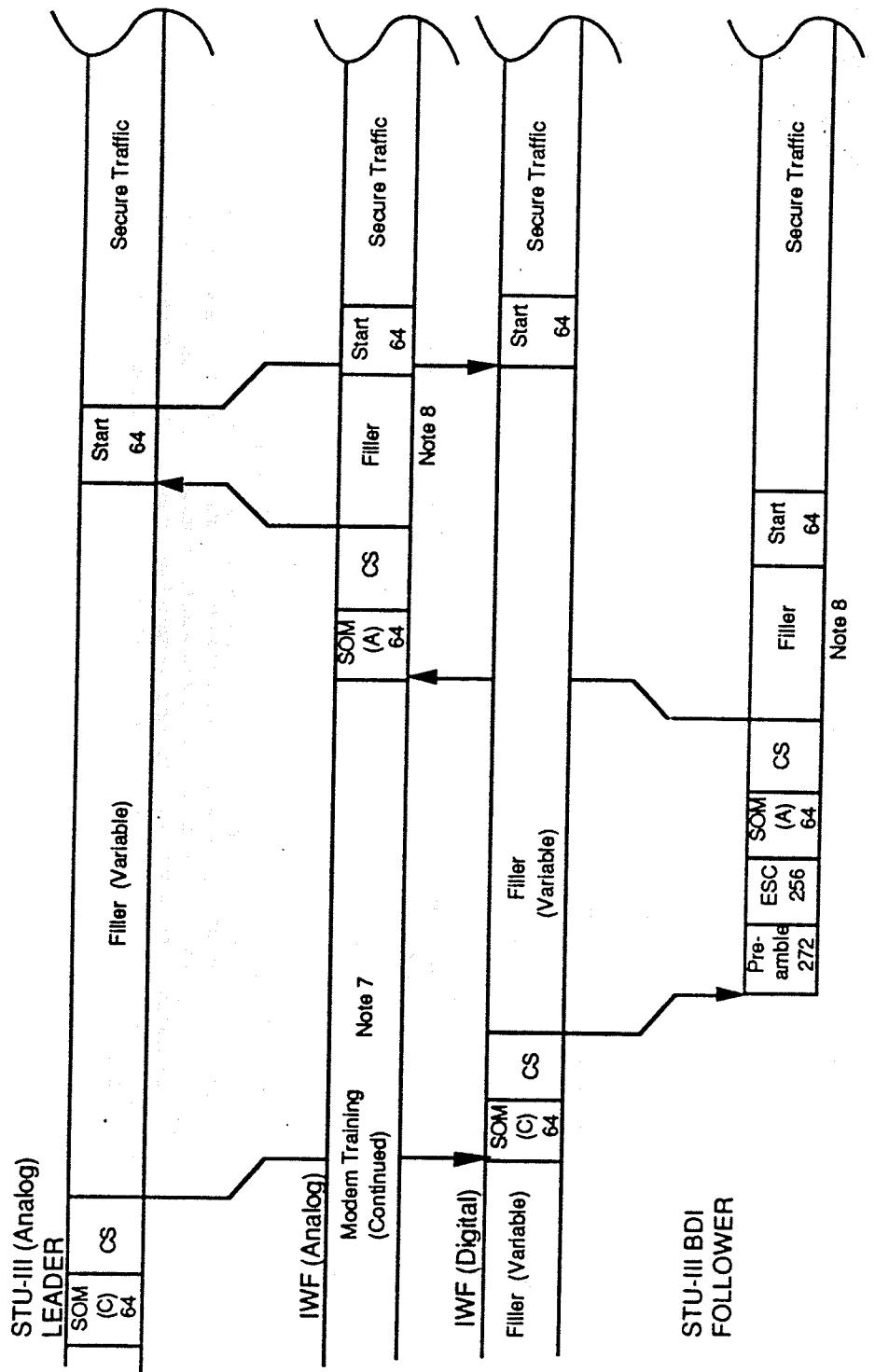


Figure 5.1.1.3.4-1 (c) IWF Full-Duplex Retrain Signaling for a STU-III Leader (Cont.)

Note 8: Filler is rate dependent as indicated. Number of bits is prior to any word stuffing or error correction.

256 bits (voice), ≥ 256 bits (data) at 2400 bps,
 576 bits (voice), ≥ 576 bits (data) at 4800 bps,
 1216 bits (voice), ≥ 1216 bits (data) at 9600 bps,
 1536 bits (voice), ≥ 1536 bits (data) at 14400 bps,
 1792 bits (voice), ≥ 1792 bits (data) at 16000 bps,
 3584 bits (voice), ≥ 3584 bits (data) at 32000 bps.

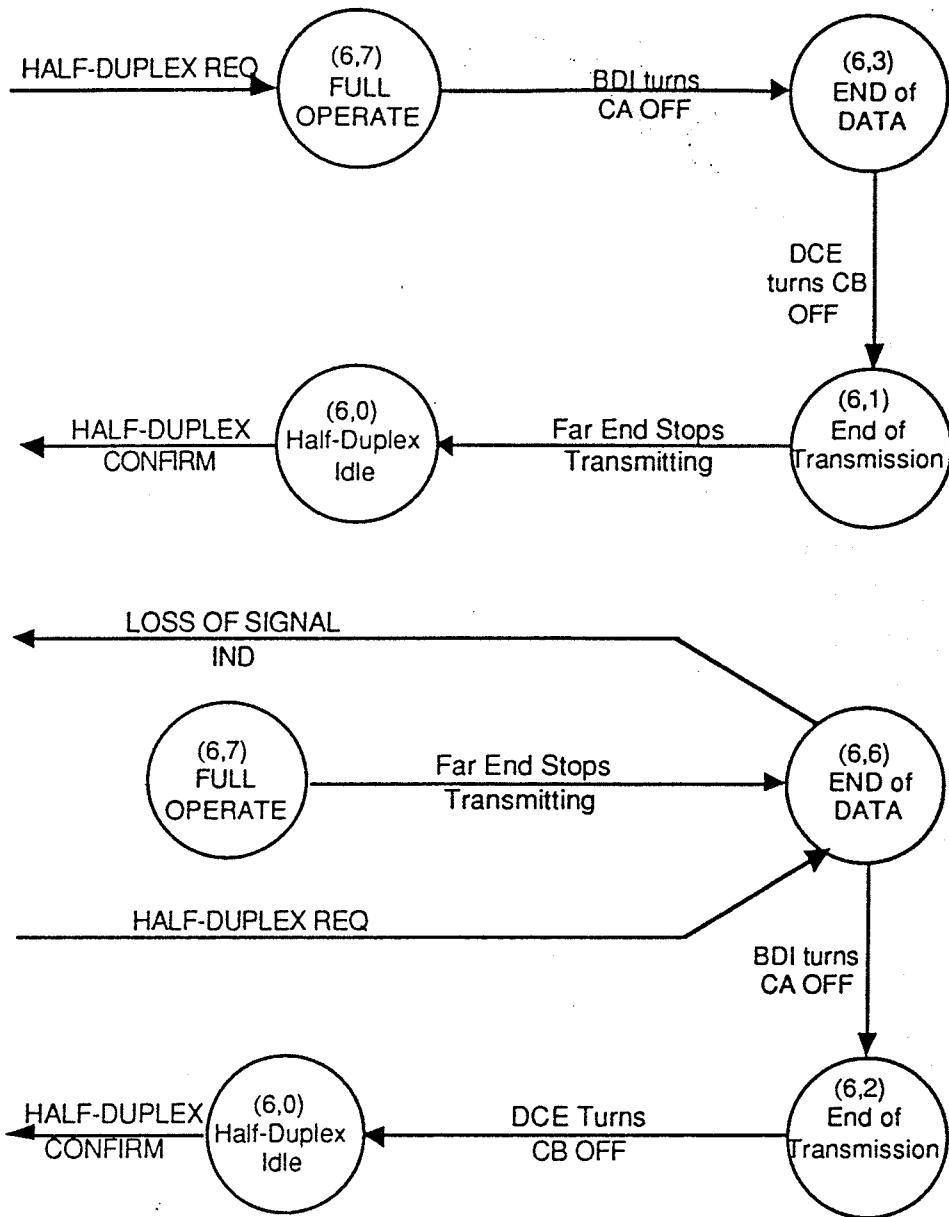
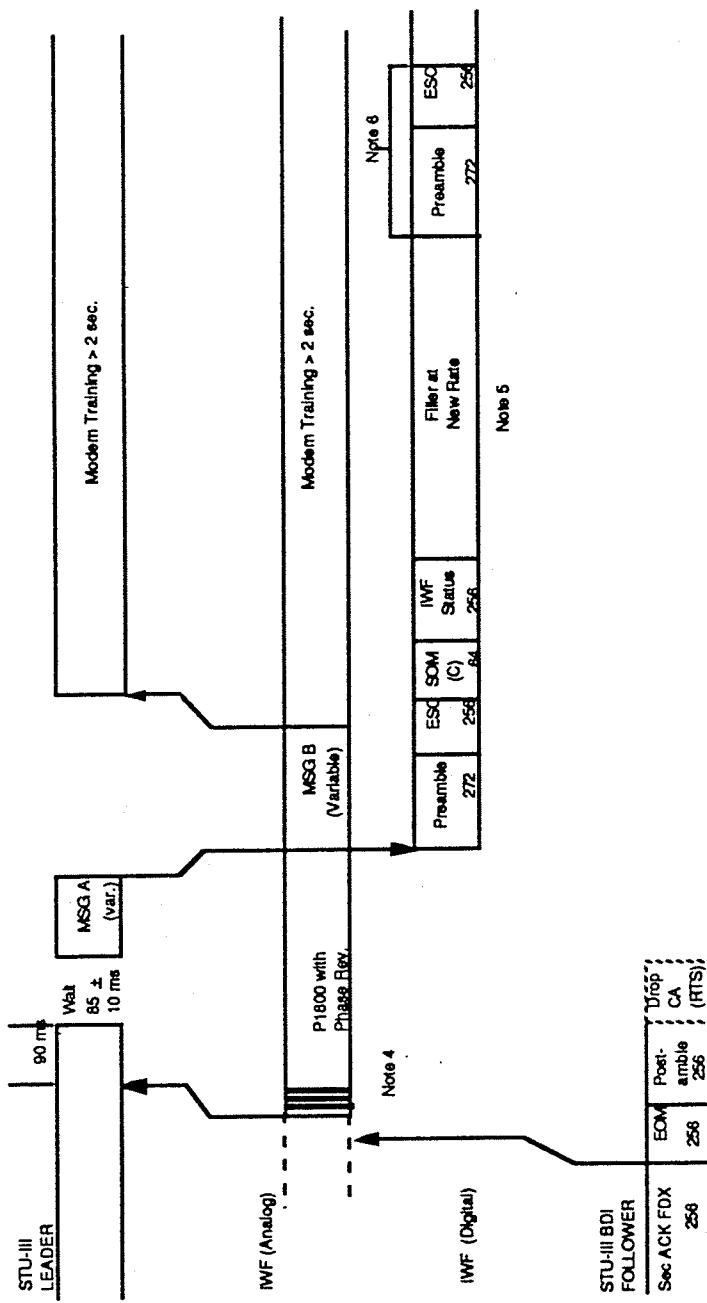


Figure 4.2.4.3-1 EIA/TIA-232 Interface State Diagram, Mode Change: Full- to Half-Duplex

One of the STUs will request simultaneous (full-duplex) service first. The state changes for this STU are illustrated in the upper half of Figure 4.2.4.4-1. The BDI shall turn Circuit CA ON, then it shall wait for the DCE to turn Circuit CB ON, then wait again for the Responder to start transmitting so that the Full Operate state is reached. The BDI shall then confirm the full-duplex mode.



Note 4: P1800 begins after at least one sec. has elapsed since the start of the ESD/ESCD. P1800 does not wait for Secure ACK FDX to be received.

Note 5: New rate or error correction begins with this filter as indicated. Number of bits is before any word stuffing.

- ≥ 1472 total bits at 2400 bps,
- ≥ 2880 total bits at 4800 bps,
- ≥ 5760 total bits at 9600 bps,
- ≥ 8640 total bits at 14400 bps,
- ≥ 9600 total bits at 16000 bps
- ≥ 19200 total bits at 32000 bps.

Note 6: If no (CH) rate change or word stuffing or error correction is required, i.e., the traffic rate is identical to the current line rate, messages in brackets shall not be transmitted and the previous filter is sent at the current line rate. If a circuit CH rate change is required, these messages shall be transmitted at the new line rate and the previous filter sent at the new rate. If a signaling rate change is required and circuit CH is not supported, these messages are not sent and the previous filter shall be transmitted word stuffed or error corrected. The Leader transmits filter followed by SOM(C), CS, Start, and secure traffic at the signaling/traffic rate. The Follower shall transmit filter until detection of SOM(C) and CS and then transmit SOM(A), CS, filter, and Start followed by secure traffic.

Figure 5.1.1.3.4-1 (b) IWF Full-Duplex Retrain Signaling for a STU-III Leader (Cont.)

The other STU will be first informed of a state change to (6,1) by the BDI. As the BDI "knows" nothing of the higher-level agreement, it shall issue a receive indication. The STU, expecting this indication, issues a full-duplex command. The BDI shall transition through the state changes as indicated in the figure until it reaches the Full Operate state. At this time it shall confirm the full-duplex mode.

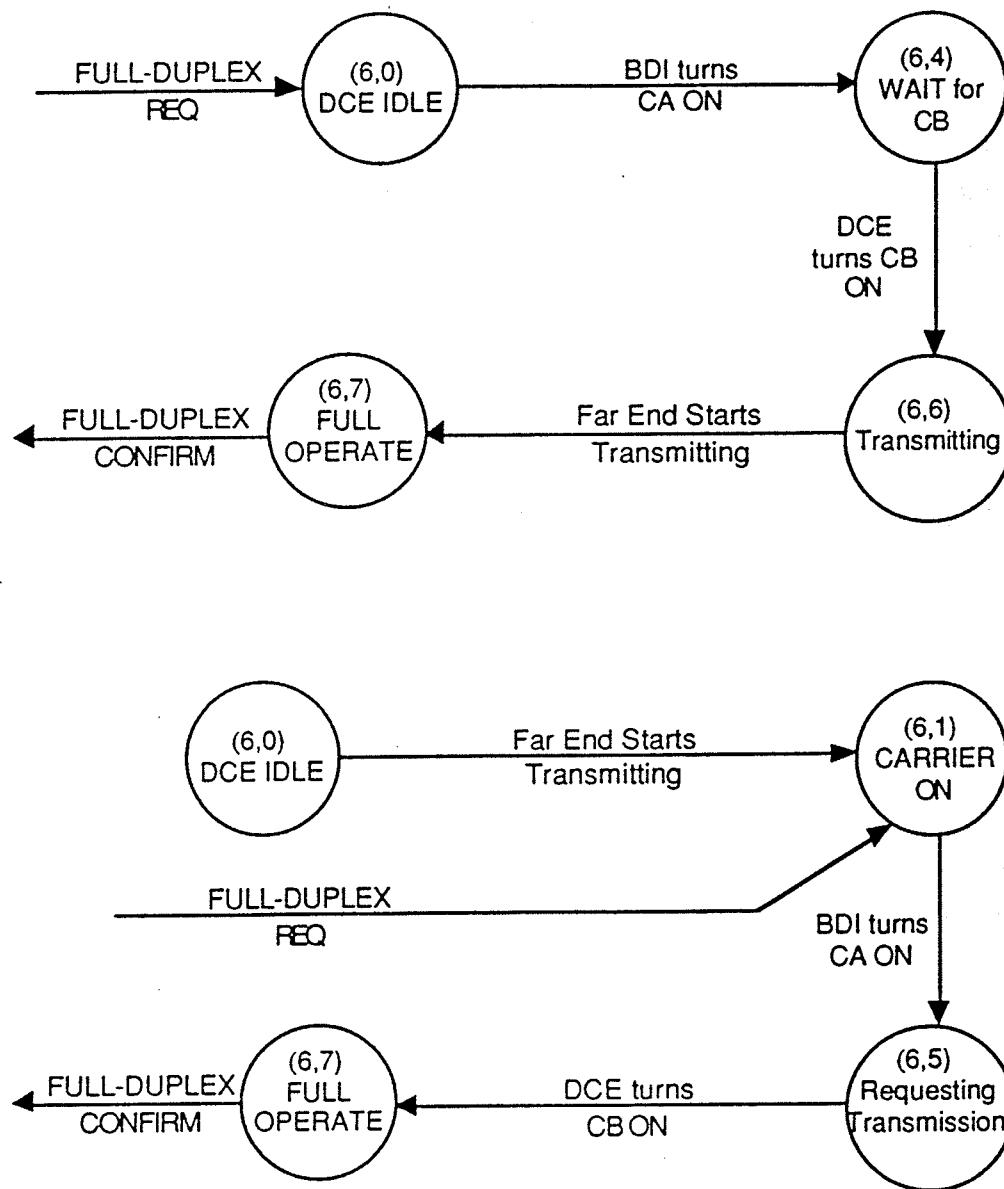


Figure 4.2.4.4-1 EIA/TIA-232 Interface State Diagram, Mode Change: Half- to Full-Duplex

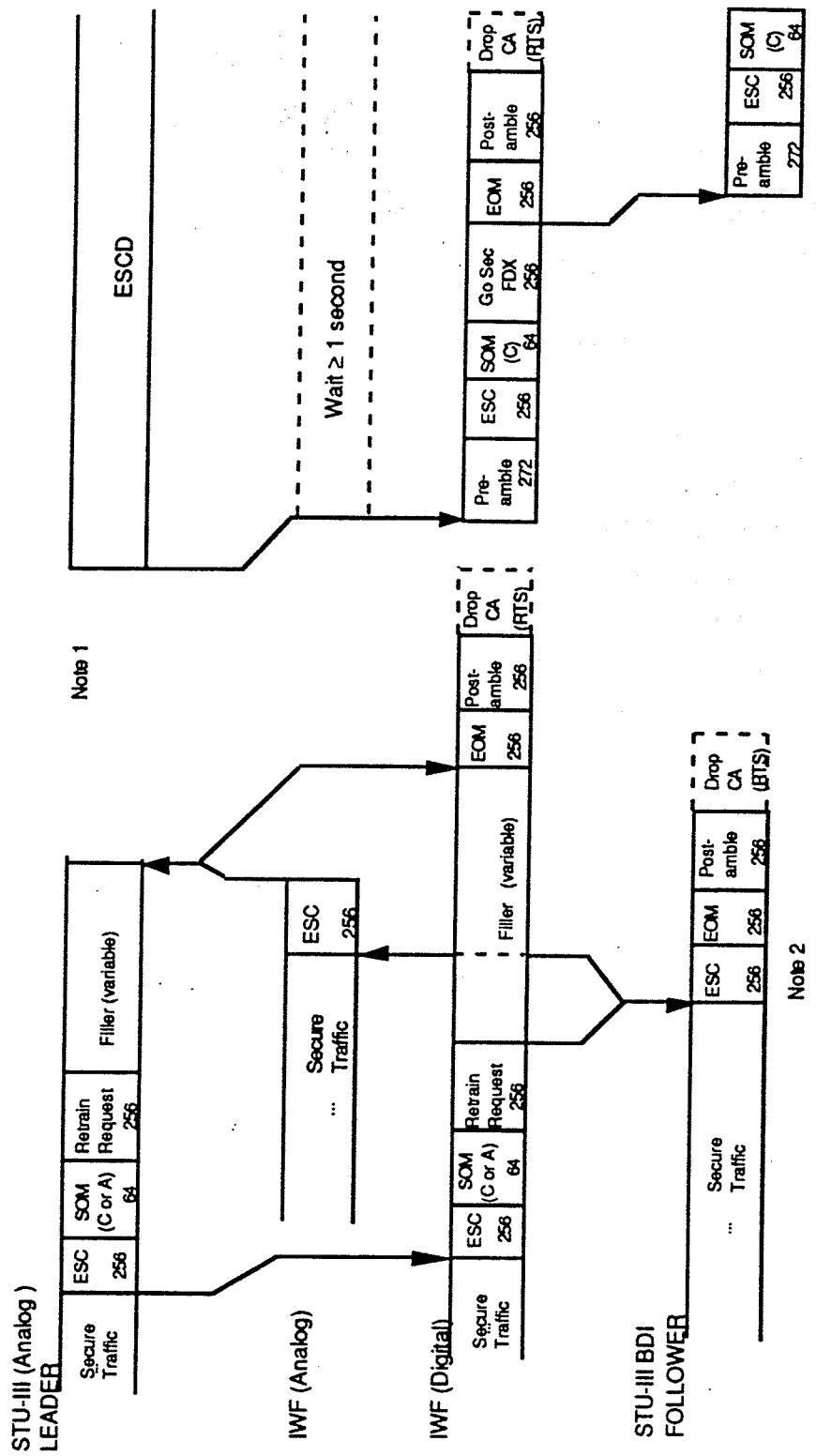


Figure 5.1.1.3.4-1 (a) IWF Full-Duplex Retrain Signaling for a STU-III Leader

Note 1: Leader must wait a minimum of 75 ms and a maximum of 1.0 seconds after detection of Escape before initiating Retrain.

Note 2: If STU-III BDI not interested in retrain, it shall transmit ESC/Retrain NACK, followed by Filler, and wait for analog STU-III to resync, as specified in FSVS-210.

4.3 Application Layer Protocols

STU-III BDI functionality that requires the exchange of specific messages has been allocated to the Application Layer, the Core STU, for the purposes of this specification. This section specifies the message structure, the processing necessary to support the structure, specific messages that support end-to-end functions, and the function protocols.

The set of common interoperable protocols for calls between STU-III type equipments via black digital interfaces is provided in this section. First the message structures and formats are defined for the various message groups, followed by descriptive sections defining all messages. Finally, the protocols are presented using extensive timing diagrams and timelines for the actual message transmissions.

The state transition diagrams shown in Figure 4.3-1 depict the highest level states and the basic conditions that cause transitions. This can serve as a roadmap to the complete call signaling. The signaling is segmented into three phases, as indicated in Figure 4.3-1.

- ❖ Alerting
- ❖ Clear Call Signaling
- ❖ Secure Call Signaling

4.3.1 Message Structure (MER)

Application messages have two basic structures. There is one structure for a single (alerting) message and another structure for a message that follows a message (e.g., mode control and variable exchange messages). The latter has been made simpler because some of the synchronization achieved in the first message may be carried over to the second.

Messages may contain bits assigned to vendors for exchanging information concerning proprietary features. Proprietary bits assigned to one vendor shall be set to zero when transmitted from other vendors' terminals.

All BDI specific messages, including alerting, miscellaneous control, and clear and secure mode control shall never be word stuffed. Where applicable, word stuffing shall apply to secure FSVS-210 signaling and traffic only. Error correction techniques may apply to both FSVS-211 and FSVS-210 signaling and traffic in a manner TBD.

5.1.1.3.4 Signaling for a Retrain Rate Change (MER)

For a retrain to a new rate, either the analog STU-III or STU-III BDI terminal initiates the process through an Escape sequence, and thus becomes the retrain Leader. The digital side signaling, beginning with the Preamble after the line drop, occurs at the current BDI line rate without rate adaption, regardless of the rate adaption status prior to the Escape. As noted in Figure 5.1.1.3.4-1, if the STU-III BDI Follower is not interested in retrain, it shall transmit Escape/Retrain NACK followed by filler, and then wait for the analog side to perform a cryptographic resynchronization.

Following the initiation of the retrain process, the STU-III BDI retrain Leader may need to send a Secure Capabilities message to the IWF informing it of the secure mode selected. (Note: The IWF must receive a Secure Capabilities message if a rate change is desired.) The signaling for this message is accomplished in the clear mode after the retrain request has been sent and the IWF has responded by dropping the line. The STU-III BDI Leader then transmits Preamble, Escape, SOM(C), the Secure Capabilities message, and EOM/Postamble. The IWF will respond with Preamble, Escape, SOM(C), ACK, and EOM/Postamble. The retrain then continues with the Leader sending Go Secure FDX per Figure 5.1.1.3.4-2. Note: If a glare should occur between a STU-III BDI terminal sending the Secure Capabilities Message and an IWF sending Go Secure, the glare shall be resolved by ignoring the Secure Capabilities message.

Figures 5.1.1.3.4-1 and 5.1.1.3.4-2 show the retrain protocol for the analog STU-III Leader and STU-III BDI Leader cases, respectively. After the retrain escape sequence, the Leader terminal becomes the Initiator for what is, essentially, a secure call setup with crypto synchronization replacing the variable exchange messages. Following the crypto sync, the terminals enter the new secure traffic mode.

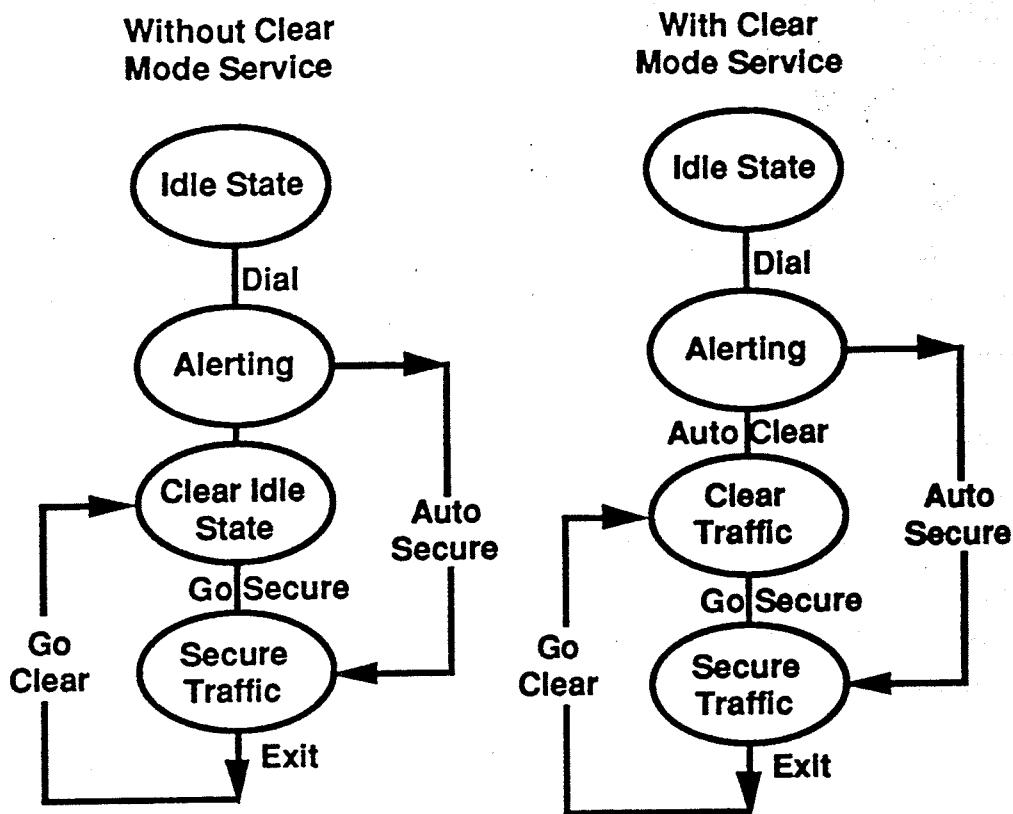


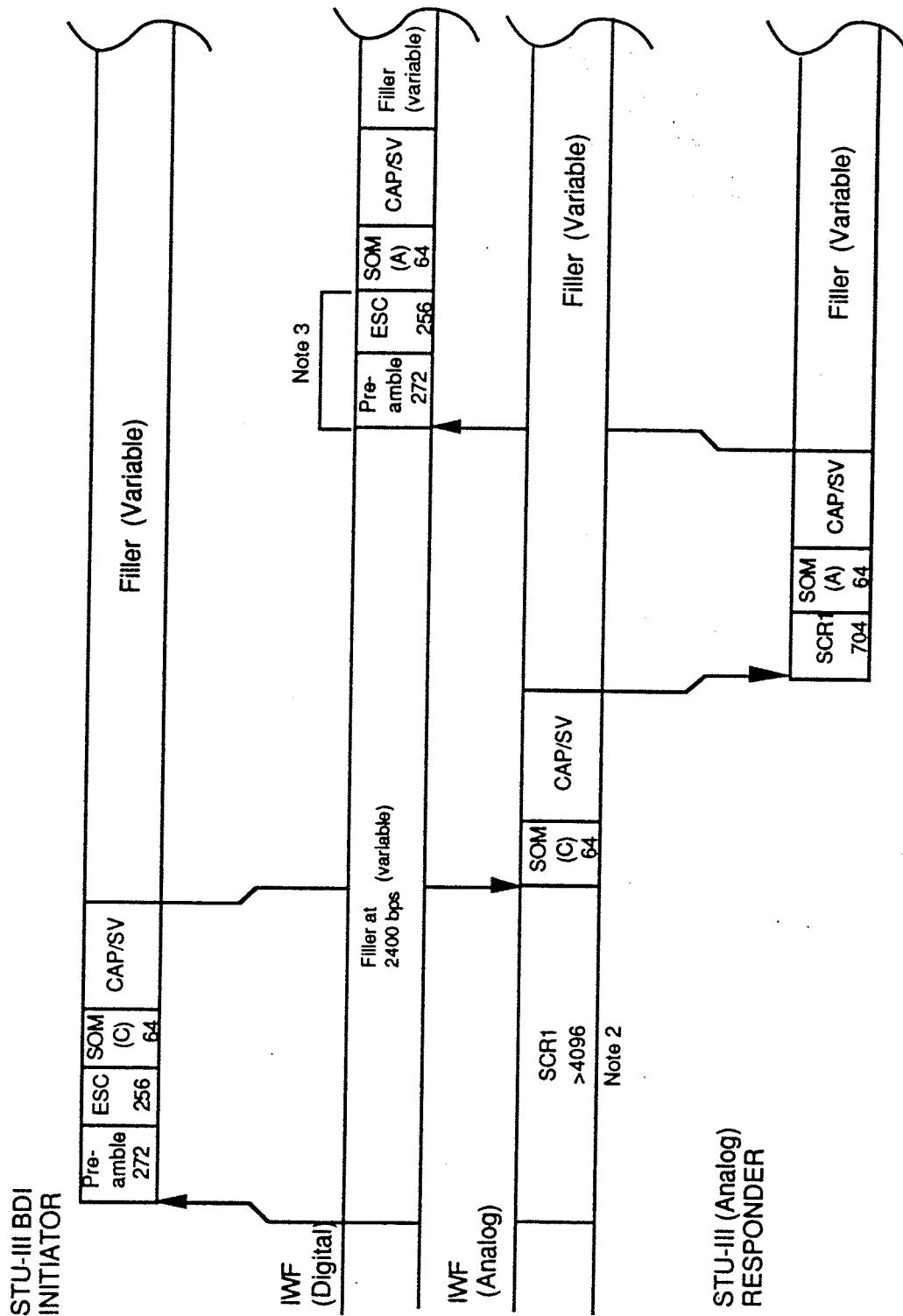
Figure 4.3-1 Overview BDI Signaling State Transition Diagrams

4.3.1.1 Alerting Message Structure (MER - OC)

The stand-alone alerting message structure is illustrated in Figure 4.3.1.1-1, and the individual fields are defined below. Note that this structure is used for the clear mode Miscellaneous Control Messages also. As shown, some messages require a second BCH block before the EOM.

Preamble	Escape	Start of Message	Message Identifier	Data	Parity	End of Message	Postamble
272 bits	256 bits	64 bits	16 bits	112 bits	128 bits	256 bits	256 bits
<-Repeated for some messages -->							

Figure 4.3.1.1-1 Basic Application Layer Alerting Message Structure



Note 1: Since there are no phase reversals on P1800, IWF Status indicates 2400.

Note 2: The IWF transmits SCR1 sequence until CAP/SV is received on the digital side. If the IWF receives CAP/SV prior to completion of modem training, it shall buffer the CAP/SV until modem training is completed.

Note 3: These messages will only be sent if there is a circuit CH rate change.

Figure 5.1.1.3.3-4 (b) IWF Full-Duplex Signaling for a STU-III Responder Not Interested in Alternate Modes and a STU-III BDI Rate Not Set for 2400 bps (Cont.)

Preamble (Pre) – the 272-bit field consisting of 17 copies of "0101 0111 0000 0011". It is used to allow the STU-III BDI to derive dabit, byte, and 16-bit word alignment. Preamble is always followed by the Escape sequence and is never word stuffed.

Escape (ESC) - a 256-bit sequence specified in FSVS-210 (§4.1.6 of Reference 1). It serves the same purpose as the STU-III Escape, which is to notify a terminal of a change of operation in the full-duplex mode. The Escape is never word stuffed. In addition, the STU-III BDI Escape sequence shall always follow the Preamble message for synchronization purposes.

Start of Message (SOM) – the 8-byte (64-bit) Initiator SOM specified in FSVS-210 (§4.1.4.1 of Reference 1). The use of the Initiator SOM in all alerting signaling allows for the exchange of digital messages during periods when no Secure Initiator is established (before either user has pressed the secure button). Initiator SOM, which is used before BDI-specific messages or messages scrambled using the GPC algorithm, is designated SOM(C). Since all alerting messages are BDI-specific, Responder SOM, which is designated SOM(A), is not used for alerting.

Message Identifier (MID) – a 2-byte (16-bit) field specifying the particular alerting message. The MIDs are specified for all alerting messages in Table 4.3.5.1-1.

Data – a 14-byte (112-bit) data field. This field of the alerting messages contains addressing information. The first seven bytes shall contain the destination address (ASCII format) and the next seven bytes shall contain the source address (also ASCII format), except for the ACK alert. The first seven bytes of the data field in an ACK alert shall contain either all hex zeroes (if standard ACK), or if the optional capability is implemented, the MID of the message it is ACKing in the first two bytes and zeros in the next five bytes. The source address (ASCII format) is contained in the last seven bytes for both ACK formats (refer to the ACK message in Section 4.3.5.1 for further details).

Parity – the 128 BCH parity bits for the preceding 128 information bits (comprising MID and Data). FSVS-210 (§3.3 of Reference 1) specifies how these bits are generated and the order they are transmitted (most significant first). (Note that 4 of the 128 bits are reserved bits rather than parity bits.)

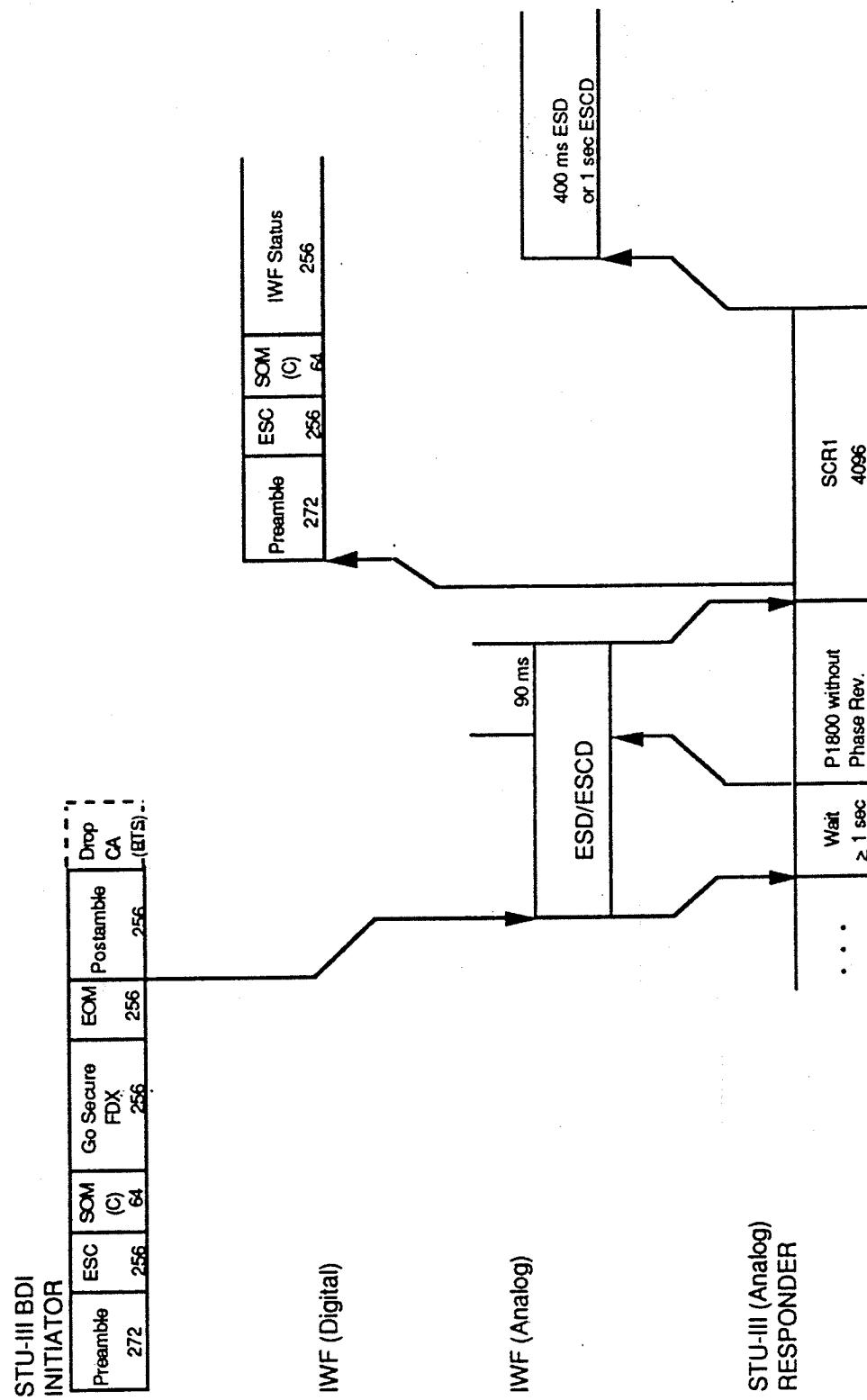


Figure 5.1.1.3.3-4 (a) IWF Full-Duplex Signaling for a STU-III Responder Not Interested in Alternate Modes and a STU-III BDI Rate Not Set for 2400 bps

End of Message (EOM) – the 128-bit (256 bits) EOM specified in FSVS-210 (§4.1.6 & 7 of Reference 1). It is identical to the Escape sequence, but is used to notify the terminal of the end of a half-duplex message segment. EOM shall always precede Postamble.

Postamble – the GPC scrambled version of 4 frames of filler (256 bits total) as specified in FSVS-210 (§4.1.5 of Reference 1). Postamble shall always follow EOM anytime carrier is to be dropped. The postamble provides compensation for coding and transmission processing delays to ensure that the preceding EOM is sent before the DCE is turned off when BDI circuit CA is turned off. Since circuit CA is turned off immediately after postamble is sent from the BDI, it is possible that the DCE might stop transmitting before postamble has been sent in its entirety. Therefore, the DCE processing time might prevent postamble from being received in full; a receiving STU-III BDI shall tolerate this.

The MID, Data and Parity fields of all alerting messages shall be scrambled by the GPC Message Scrambling Pattern, the scramble algorithm that FSVS-210 (Reference 1, Figure 3-3) specifies for messages sent by the Secure Initiator. As with the SOM(C), this design allows for the use of scrambled digital messages during periods when no Clear Initiator is established. The scrambler shall be reseeded, as specified in Reference 1, for each alerting message.

4.3.1.2 Mode Control and Variable Exchange Message Structure (MER - OC)

For certain consecutively transmitted Mode Control messages, or for certain consecutively transmitted Mode Control/Variable Exchange message pairings, the messages shall be transmitted using the concatenation method described below. The applicable Mode Control and Mode Control/Variable Exchange paired messages are completely defined under Sections 4.3.5 and 4.3.6. This message concatenation method is not applicable to clear mode control, Alerting, or Miscellaneous Control messages.

For consecutively transmitted Mode Control messages, the EOM/Postamble that would have terminated the first message and the Preamble/Escape that would have begun the second message shall be deleted and shall be replaced with Filler and Escape as shown in Figure 4.3.1.2-1. For consecutive Mode Control/Variable Exchange paired messages, the EOM/Postamble that would have terminated the Mode Control message and the Preamble/Escape that would have begun the Variable Exchange message shall be deleted and shall be replaced with Filler as shown in Figure 4.3.1.2-1. If a Circuit CH change occurs, Preamble/Escape is needed before the SOM

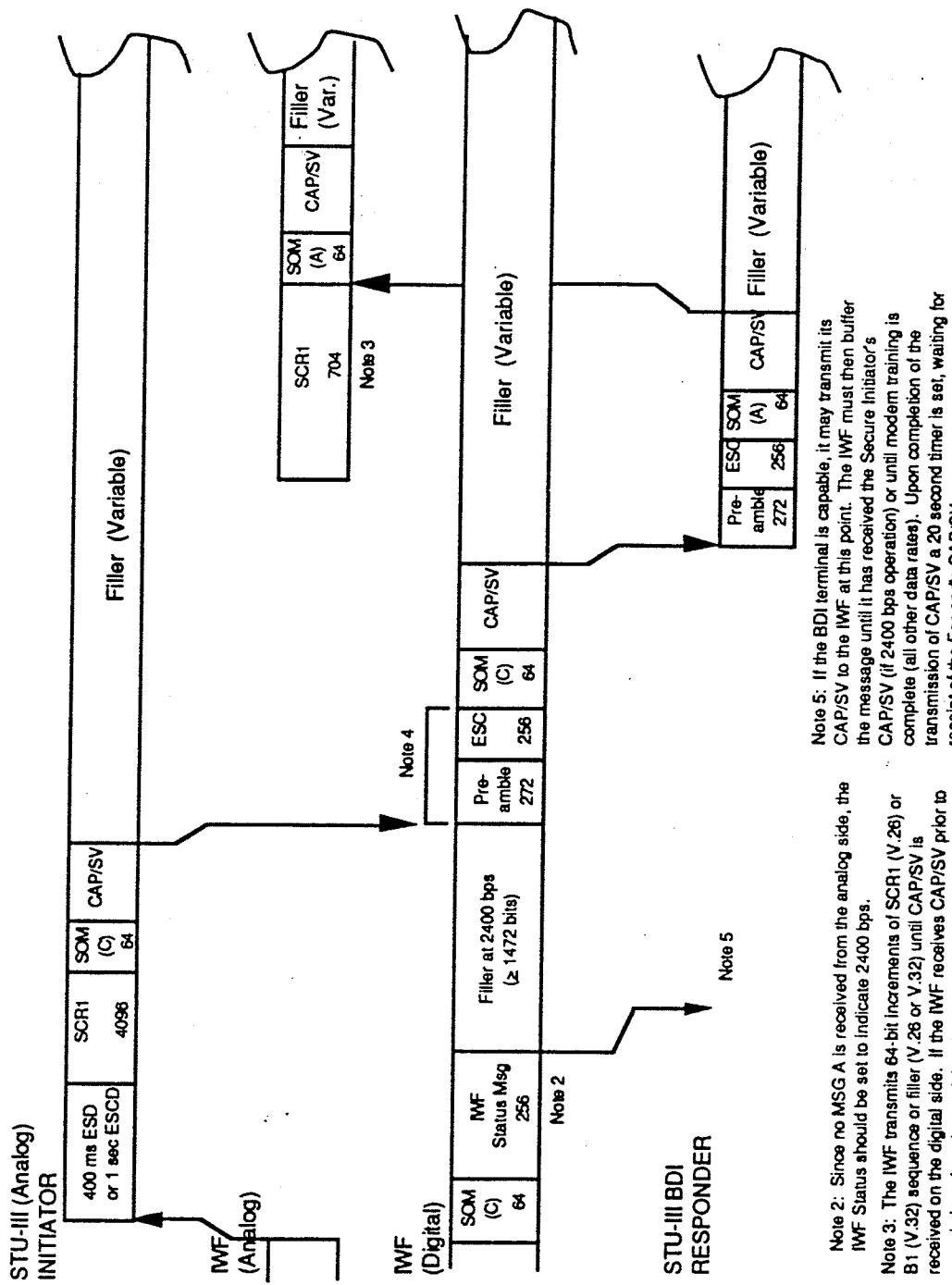


Figure 5.1.13.3-3 (b) IWF Full-Duplex Signaling for a STU-III Initiator Not Interested in Alternate Modes and a STU-III BDI Rate Not Set for 2400 bps (Cont.)

following the rate change. This case is not shown in Figure 4.3.1.2-1. All FSVS-210 messages shall be transmitted as described in that document.

For full-duplex secure call setup, the sequence Filler, ESC, SOM(C), MID, data/parity shall be repeated for each additional Mode Control message, while Filler, SOM(C or A), MID, data/parity shall be repeated for each additional Variable Exchange message. For transmission of Mode Control messages in half-duplex operation, an EOM and Postamble shall follow the data/parity field of the last message. For Variable Exchange messages in half-duplex, the message will be terminated with an FSVS-210 EOM, followed by an FSVS-211 EOM and Postamble. The individual fields for these messages are defined below.

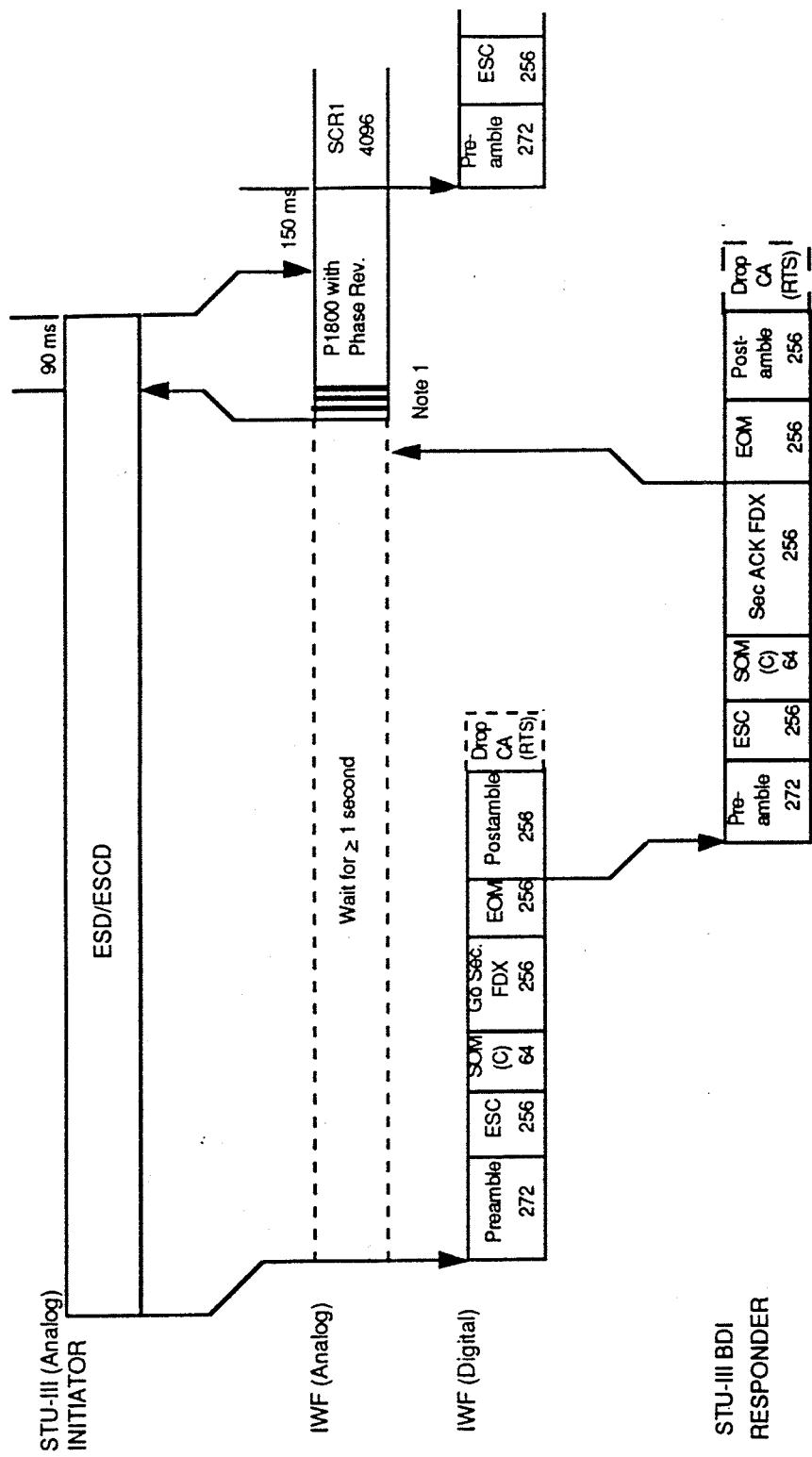
Preamble (Pre) – same as for alerting messages.

Escape (ESC) – same as for alerting messages. Escape shall always precede the SOM of a Mode Control message. Escape shall always follow Preamble.

Start of Message (SOM) – the 8-byte (64-bit) Initiator SOM specified in FSVS-210 (§4.1.4.1 of Reference 1) shall be used for clear Mode Control messages and all other BDI-specific messages. The Initiator or Responder SOM specified in FSVS-210 shall be used for Variable Exchange messages that are specified in FSVS-210. Note that the first secure Mode Control message (Go Secure Full-Duplex or Go Secure Half-Duplex) establishes the Secure Initiator/Responder roles for two communicating terminals. Initiator SOM, which is used before BDI-specific messages, both initiator and responder, or messages scrambled using the GPC algorithm, is designated SOM(C). Responder SOM, which is only used before FSVS-210 messages scrambled using the GPA algorithm, is designated SOM(A).

Message Identifier (MID) – a 2-byte (16-bit) field specifying the particular Mode Control or Variable Exchange message. The MIDs for secure Mode Control messages are specified in Table 4.3.6.1.1.1-1, and those for clear Mode Control messages are specified in Table 4.3.5.2.1.3-1. MIDs for Variable Exchange messages are specified in Reference 1.

Data/Parity – a variable length field depending on the particular message. Mode Control messages may, as an optional capability, include an ASCII source address in the last seven bytes of their data fields.



Note 1: P1800 begins after at least one sec. has elapsed since the start of ESD/ESCD.
P1800 does not wait for Secure ACK FDX to be received.

Figure 5.1.1.3.3-3 (a) IWF Full-Duplex Signaling for a STU-III Initiator Not Interested in Alternate Modes and a STU-III BDI Rate Not Set for 2400 bps

End of Message (EOM) – same as for alerting messages.

Postamble - same as for alerting messages.

In the secure mode, the MID, data/parity, and filler fields are scrambled by either the GPC scrambler (Initiator) or by the GPA scrambler (Responder). Both are as specified in FSVS-210 (Reference 1). The scrambler shall be reseeded for each message as specified in FSVS-210. All clear call messaging, including alerting and clear call negotiation, shall use GPC scrambling and Initiator SOM, designated SOM(C). Responder SOM is designated SOM(A). The SOM(C) and SOM(A) of secure mode control and variable exchange messages which are defined in FSVS-210 shall be used with Initiator and Responder messages, respectively, as specified in FSVS-210. For messages not defined in FSVS-210, SOM(C) and GPC message scrambling shall be used.

Pre	ESC	SOM	MID	Data/ Parity (var.)	Filler	ESC *	SOM	MID	Data/ Parity (var.)	Filler or EOM**, EOM, and Postamble
272	256	64 bits	16 bits		(var.)	256	64 bits	16 bits		

*This field applies to Mode Control messages only.

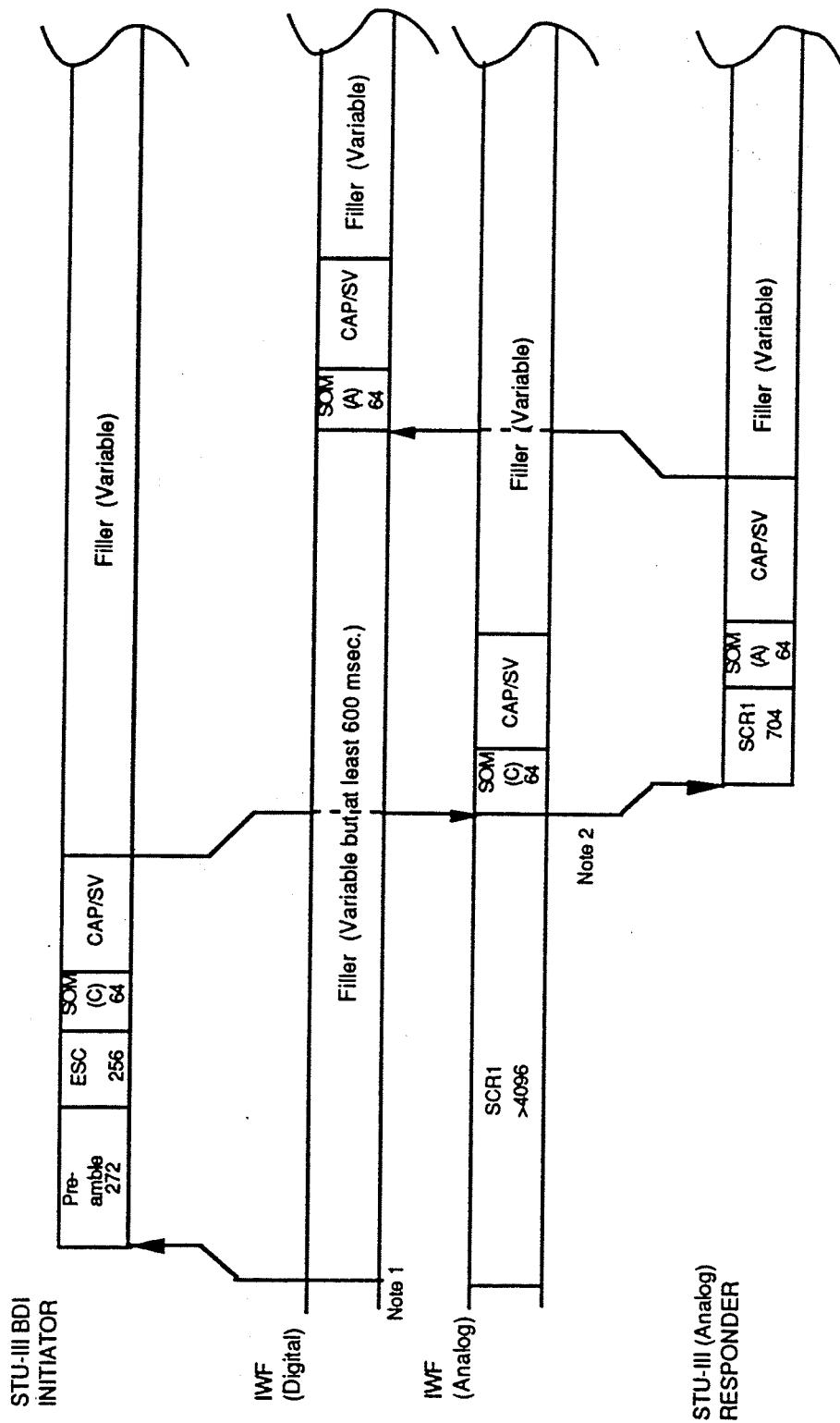
**FSVS-210 EOM, used for HDX Variable Exchange messages only.

Figure 4.3.1.2-1 Basic Application-Layer Multiple Message Structure

4.3.2 Start of Message Detection (MER)

The STU-III BDI searches for the SOM pattern to determine the start of a message. The preamble may be used to derive dabit, byte, or word sync. This initial synchronization establishes boundaries on which the SOM may start. Since the 272 bits of preamble might not be received in full, the preamble cannot be used to determine the start of message, SOM.

If the STU-III BDI is configured for operation over a constant DCD channel, it shall rely on EOM detection to determine when the channel is available for half-duplex transmissions. During half-duplex signaling, if a message is not being received, the STU-III BDI shall be able to seize the channel when RTS is asserted at the data port. When the STU-III BDI starts a half-duplex transmission, it shall disable its SOM detection until the transmission is complete.



Note 1: Since there are no phase reversals on P1800, IWF Status indicates 2400.

Note 2: The IWF transmits SCR1 sequence or filler until CAP/SV is received on the digital side. If the IWF receives CAP/SV prior to completion of modem training, it shall buffer the CAP/SV until modem training is completed.

Figure 5.1.1.3.3-2 (b) IWF Full-Duplex Signaling for a STU-III Responder Not Interested in Alternate Modes and a STU-III BDI Rate Set for 2400 bps (Cont.)

If the STU-III BDI is not configured for a constant DCD channel, it shall rely on DCD to determine when the channel is available for half-duplex transmissions. If DCD is ON, the channel is unavailable for transmission, and the STU-III BDI shall enable its SOM detection. During half duplex signaling, it shall not attempt to raise RTS until DCD is OFF.

4.3.3 End of Message Detection (MER)

The STU-III BDI shall search for an EOM pattern to determine when the message currently being received is complete. All messages sent in half-duplex (alerts, clear, and secure STU-III) terminate with an EOM and postamble, although the postamble might not be transmitted in full by the DCE before circuit CA is turned off. When EOM is detected or DCD transitions OFF, the STU-III BDI shall consider the transmission to have ended and the channel to be idle. Following an EOM, the receiving terminal shall delay any subsequent transmission for the postamble duration plus the remainder of the 150 ms link idle time, regardless of whether or not postamble is received in full.

For channels with constant DCD, EOM detection is the only way to determine when a transmission is complete. If the EOM is not detected due to a fade or noise hit, the STU-III BDI shall remain in receive mode until one of the following occurs:

- a. another EOM is received
- b. a timeout occurs in STU-III call setup, in which case the call will fail
- c. the expected number of data bits have been received, in which case the terminal may request a retransmission or proceed with the call if it is certain that no message can follow
- d. a user interrupt occurs (transmit override)

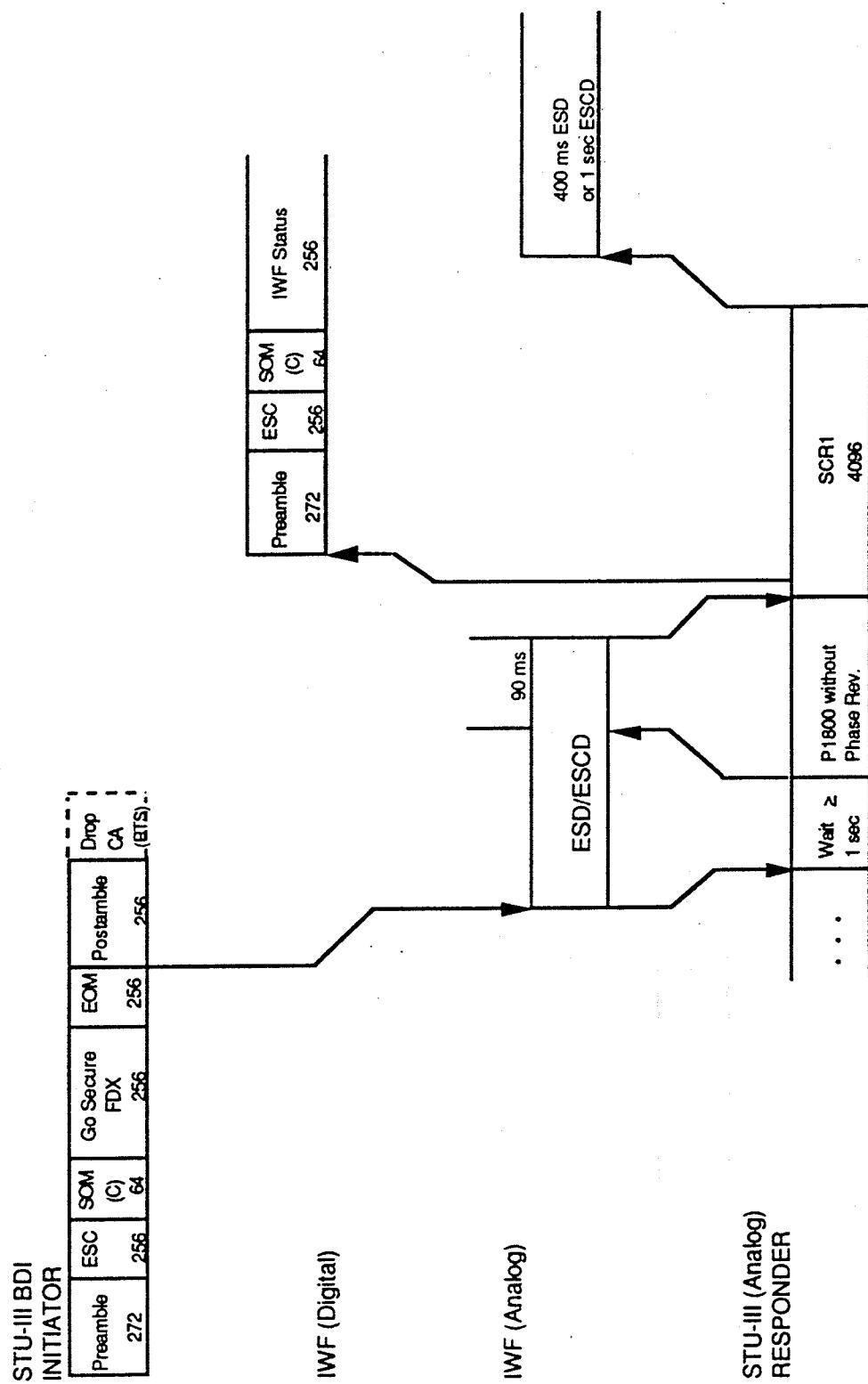


Figure 5.1.1.3.3-2 (a) IWF Full-Duplex Signaling for a STU-III Responder Not Interested in Alternate Modes and a STU-III BDI Rate Set for 2400 bps

4.3.4 Message Error Correction (MER)

Each alerting message block contains a 16-byte BCH parity tag for error correction. The algorithm is described in FSVS-210 (Reference 1). A STU-III BDI terminal shall correct all errors for blocks having up to 18 bit errors in each received alert. It shall also create the BCH parity for the alerting messages that it transmits. Alerts received with excessive (uncorrectable) bit errors will be considered corrupted and shall be ignored by the STU-III BDI terminal.

4.3.5 Clear Mode Operation (MER)

The BDI clear call mode shall be a Minimum Essential Requirement (MER) in STU-III BDI terminals. It is intended to provide the alerting necessary to establish a communications path between two STU-III BDI terminals. Implementation of the clear call mode does not require the inclusion of a clear mode vocoder or data mode.

4.3.5.1 Alerting (MER and OC)

The alerting protocol is specified for operation over dedicated digital channels that provide no signaling and supervision capability for initial call establishment. However, all STU-III BDI and IWF terminal equipment shall have the alerting capability implemented, regardless of whether or not the host network provides such capability.

Table 4.3.5.1-1 specifies the messages required to support the alerting protocol. The Ring/Y, Ring ACK/Z, and the Off-Hook/Z alerting messages contain the Y and Z Messages as specified in Section 4.3.5.2.1.1.

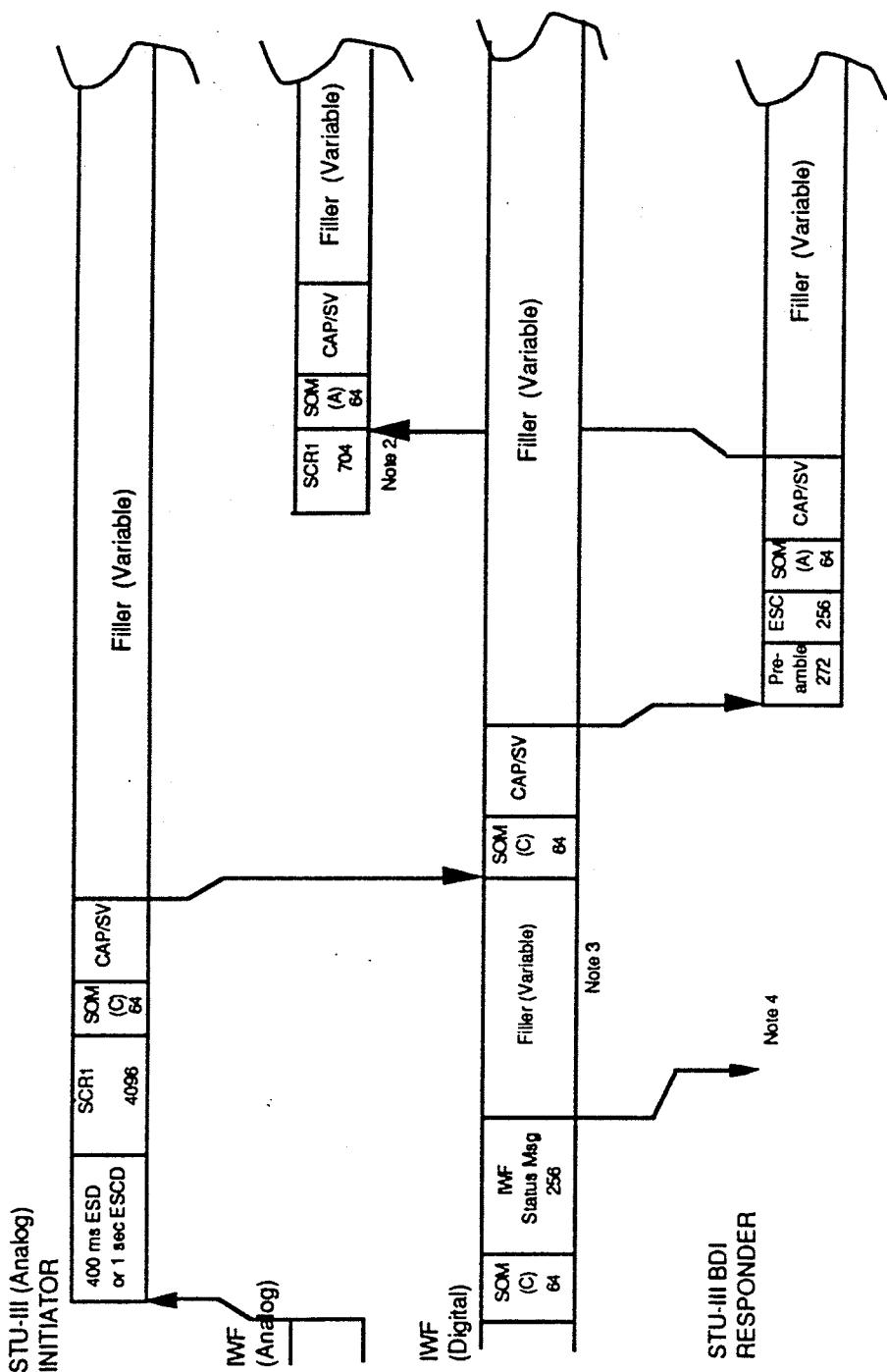


Figure 5.1.1.3.3-1 (b) IWF Full-Duplex Signaling for a STU-III Initiator Not Interested in Alternate Modes and a STU-III BDI Rate Set for 2400 bps (Cont.)

Message	MID (Hex)	Purpose
Ring/Y	2000	Ring alerting, channel establishment, and clear capability exchange
Ring ACK/Z	2033	Ring back to dialer and clear capability exchange
Busy	2055	Busy signal to dialer
Off-Hook/Z	2066	Line seizure indication to dialer and clear capability exchange
On-Hook	2099	Release of call indication
ACK	2044	Acknowledgment of alert reception

Table 4.3 - 1-1 Alerting Messages

Alerting messages shall always be transmitted in complete BCH blocks and scrambled, using the GPC scrambler when transmitted by either the calling or called terminal. All alerting messages shall be preceded by the Initiator SOM, SOM(C), defined in FSVS-210.

Each transmitted alerting message must be acknowledged by the receiving end with either a Ring ACK/Z, Busy, Off-Hook/Z, or Acknowledge alerting message. If the transmitter of an alerting message fails to receive an acknowledgment within a timeout period of 3.3 ± 0.7 seconds it shall retransmit the alerting message. (Optionally, an extended mode timeout of an additional 6 seconds may be used. BDI terminals shall have this as a user configurable option. It is suggested that calls involving IWFs use the extended mode timeouts.) After three unacknowledged retransmission attempts (for a total of four), the transmitter shall timeout, revert to the on-hook state, and notify its user. If a Y/Z exchange occurred before the timeout, the transmitter shall send the On-Hook alerting message before reverting to the on-hook state. Alerting signaling is specified in Sections 4.3.5.1.1 and 4.3.5.1.2. The BDI alerting messages are described below.

Ring/Y The Ring/Y alert shall be transmitted by a STU-III BDI terminal as the first message in an alerting sequence. The receiving equipment shall recognize this message as an indication to ring. This is similar to the ring voltage on a TELCO circuit that causes a telephone to ring. The receiving equipment shall ring for a maximum of 180 ± 20 seconds, or until an on-hook alert is received or the receiver goes off-hook. If the timeout is reached, the On-Hook alert shall be sent. The Ring/Y shall be acknowledged by the receiving equipment with a Ring ACK/Z, Off-Hook/Z, or a Busy. The transmitter shall accept an Off-Hook/Z as an

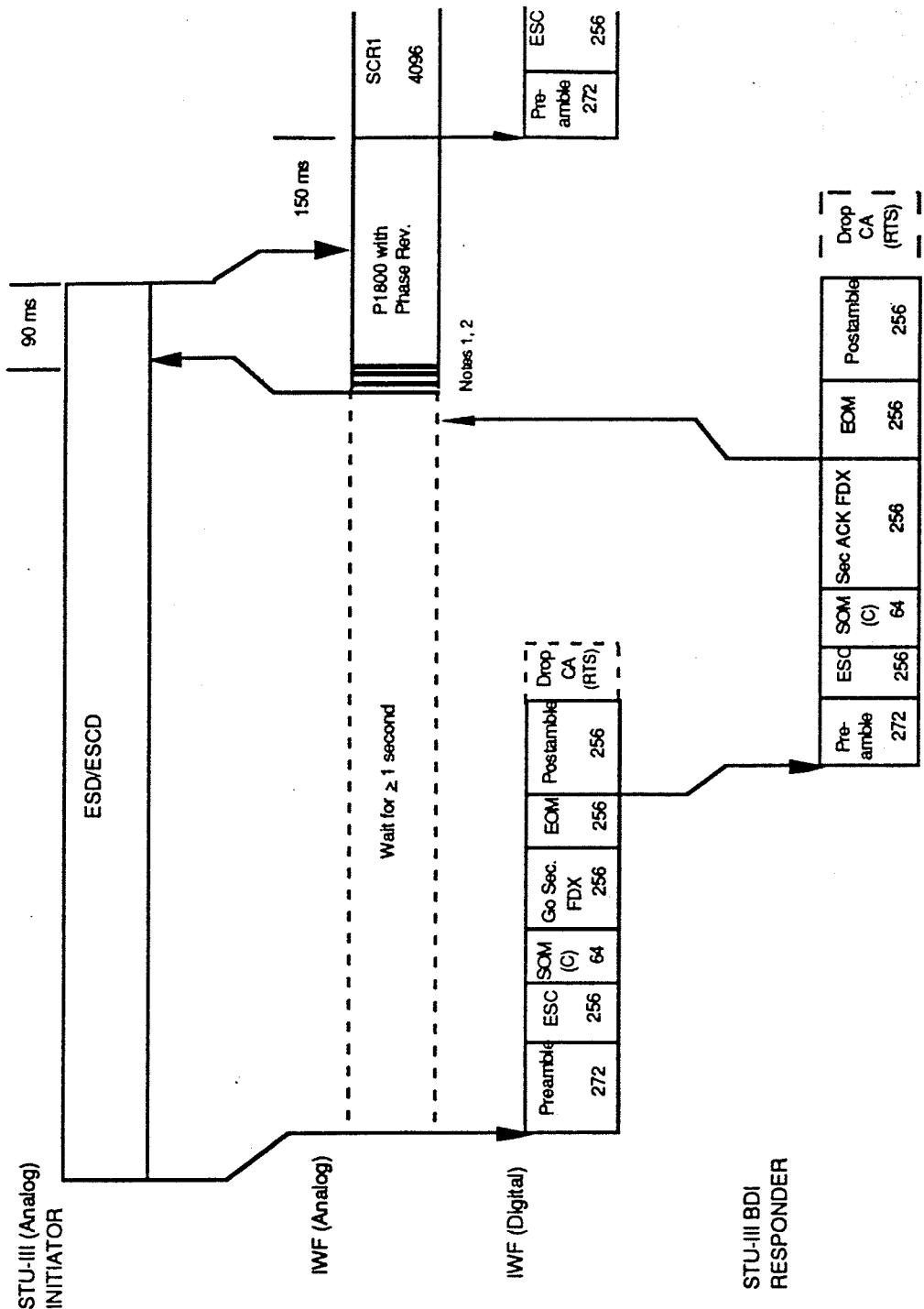


Figure 5.1.1.3.3-1 (a) IWF Full-Duplex Signaling for a STU-III Initiator Not Interested in Alternate Modes and a STU-III BDI Rate Set for 2400 bps

acknowledgment in the case of Ring ACK/Z corruption. The Ring/Y message shall contain two BCH blocks. The first BCH block shall contain the Ring alert. The second BCH block shall contain the Y Message (clear capabilities) as defined in Section 4.3.5.2.1.1. Note: If the received Y message contains a BDI rate that is incompatible with the receiving terminal's (or IWF's) BDI rate, the Ring/Y message should be ignored, and no Z message should be returned (see Section 4.3.5.2.1.1).

Ring ACK/Z The Ring ACK/Z alert serves two purposes. First, it is a ringback indication to the transmitter of the Ring/Y alert. Second, it is the acknowledgment to the transmitter that the Ring/Y was received. It shall be transmitted by the STU-III BDI terminal if a Ring/Y alert has been received and the STU-III BDI terminal is not busy. A BDI may, however, transmit an Off-Hook/Z alert without a preceding Ring ACK/Z alert, when operating in an auto-answer mode or in the event of a ring glare condition. The Ring ACK/Z message shall contain two BCH blocks. The first BCH block shall contain the Ring ACK alert. The second BCH block shall contain the Z Message (clear capabilities) as defined in Section 4.3.5.2.1.1.

Busy The Busy alert shall be transmitted by the STU-III BDI terminal, if it can respond, if it is not ready to answer an incoming call and has received a Ring/Y alert. It shall be recognized by the receiving equipment as a negative acknowledgment to the Ring/Y alert.

Off-Hook/Z The Off-Hook/Z alert shall be transmitted by the STU-III BDI terminal as an indication to the receiving equipment that it is answering the incoming call. This message shall be transmitted by a STU-III BDI after the user has gone Off-Hook, if a Ring/Y alert was received and after the Ring ACK/Z alert has been transmitted. Alternatively, the Off-Hook/Z may be transmitted without a preceding Ring ACK/Z alert if the device has an automatic answer. The transmitter of this alert shall wait for an ACK alert as an acknowledgment that the Off-Hook/Z was received correctly. The Off-Hook/Z message shall contain two BCH blocks. The first BCH block shall contain the Off-Hook alert. The second BCH block shall contain the Z Message (clear capabilities) as defined in Section 4.3.5.2.1.1.

On-Hook The On-Hook alert shall be transmitted by the STU-III BDI terminal as an indication to the receiving equipment that it is releasing the call in progress. The receiver shall

5.1.1.3.3 Signaling for STU-III Not Interested in Alternate Modes (MER)

Figures 5.1.1.3.3-1 through 5.1.1.3.3-4 illustrate the signaling for cases where either the analog STU-III or the STU-III BDI is not interested in alternate modes, and therefore, there is no Message A/B exchange on the analog side. The IWF shall not send Message A to a STU-III that does not offer, nor send Message B to an analog STU-III that does not respond to an offer of, alternate modes. In this situation, signaling occurs at 2400 bps. The digital side may or may not be set initially for 2400 bps signaling, resulting in two digital side possibilities (no rate change, rate change) for each of the two analog side scenarios (STU-III Initiator, STU-III Responder).

Figure 5.1.1.3.3-1 illustrates the scenario in which the analog STU-III Initiator is not interested in alternate modes. In this case, the IWF must generate an IWF status message indicating 2400 bps operation only, since it did not receive a Message A. In Figure 5.1.1.3.3-2, the STU-III BDI is the Initiator and the analog STU-III Responder is not interested in alternate mode signaling. The IWF again transmits an IWF Status message, indicating to the STU-III BDI that the analog STU-III has required 2400 bps operation only. Since the digital side is already configured for a 2400 bps signaling rate in these two cases, no rate change is required, and signaling proceeds normally.

Figures 5.1.1.3.3-3 and 5.1.1.3.3-4 show situations similar to the two above, except that the digital side is initially set to a rate other than 2400 bps. The protocols are similar to those already presented, but the filler after the IWF status message is sent at the new signaling rate of 2400 bps. This is followed by the *Preamble* and *Escape* messages to permit synchronization, if a circuit CH rate change occurs. If the signaling rate change does not involve a circuit CH rate change, then the Preamble and ESC are not transmitted and the filler and following signaling is sent rate adapted with word stuffing or error correction.

use this alert as an indication to:

- a. stop ringing
- b. go on-hook.

The transmitter of this alert shall wait for an ACK alert as an acknowledgment that the On-Hook was received correctly.

Acknowledge (ACK) This alert shall be transmitted as an acknowledgment when the following alerts are received.

Off-Hook/Z

On-Hook

In addition, the ACK alert shall be transmitted in response to Miscellaneous Control Messages as specified in Section 4.3.5.2.1.2.

A terminal transmitting an ACK shall not expect a response. It shall, however, accommodate the case of the ACK being corrupted. In this case, the terminal transmitting the alert for which an ACK is pending shall retransmit the alert. The alert shall then be acknowledged by the receiving terminal with the ACK alert.

The ACK message format (including an Optional Capability) is shown in Figure 4.3.5.1-1. The Optional Capability (OC) allows the ACK alert to contain the MID of the alert it is acknowledging in the first 16 bits of the data field. STU-III BDIs that do not implement this (OC) are not required to examine the first 16 bits of the data field.

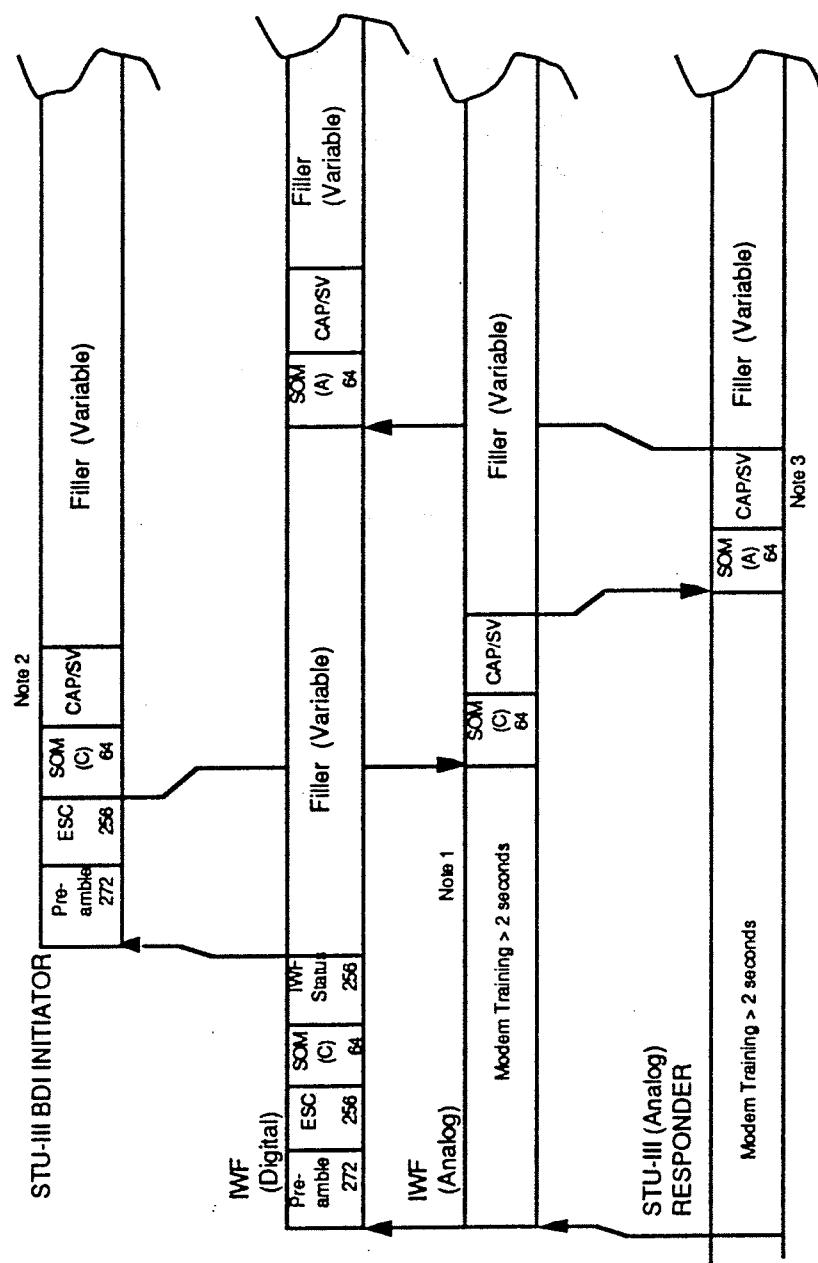


Figure 5.1.1.3.2-2 (b) IWF Full-Duplex Signaling for No Negotiated Rate Change with a STU-III BDI Initiator (Cont.)

ACK Message

MID 16 bits	Unused 7 bytes (transmit hex zeros)	Source Address 7 bytes	Parity 16 bytes
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ACK Message (Optional Capability)

MID 16 bits	ACKed Message MID 16 bits	Unused 5 bytes	Source Address 7 bytes	Parity 16 bytes (128 bits)
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MID - 2044 hex

ACKed Message MID - contains the MID of the message that the ACK is acknowledging

Unused - reserved part of data field, all set to hex zeros, 7 bytes for standard ACK, 5 bytes for OC

Digital Source Address - 7 bytes

Parity - for the BCH block encoding, 16 bytes

Figure 4.3.5.1-1 ACK Message Formats

4.3.5.1.1 Alert Addressing (MER - OC)

Alerts shall contain source and destination addresses so that they may be directed to individual subscribers within a network. Since some networks will provide addressing (in the form of telephone numbers), the terminal address shall be user programmable. (It is recommended that the terminal address be changed only by the network/systems administrator in order to reduce the risk of duplicate addresses.) The terminal shall be initially set by the manufacturer for the terminal address specified below. Addresses are specified in ASCII format. The initial seven digit address of a subscriber shall consist of the two-digit Numeric Product Code followed by the five least significant digits of the terminal's serial number, comprised of the numeric digits 0-9 only. The Numeric Product Code is defined for all analog STU-III terminal types in FSVS-220, Section 3.1.1.2, pages 3-2 and 3-3. It is a two digit numeric code which indicates the vendor, type, and STU Family of Equipment. By supplying this initial address, the user is guaranteed a globally unique address. Numeric Product Codes for STU-III BDI and IWF equipments are defined in Table 4.3.5.1.1-1.

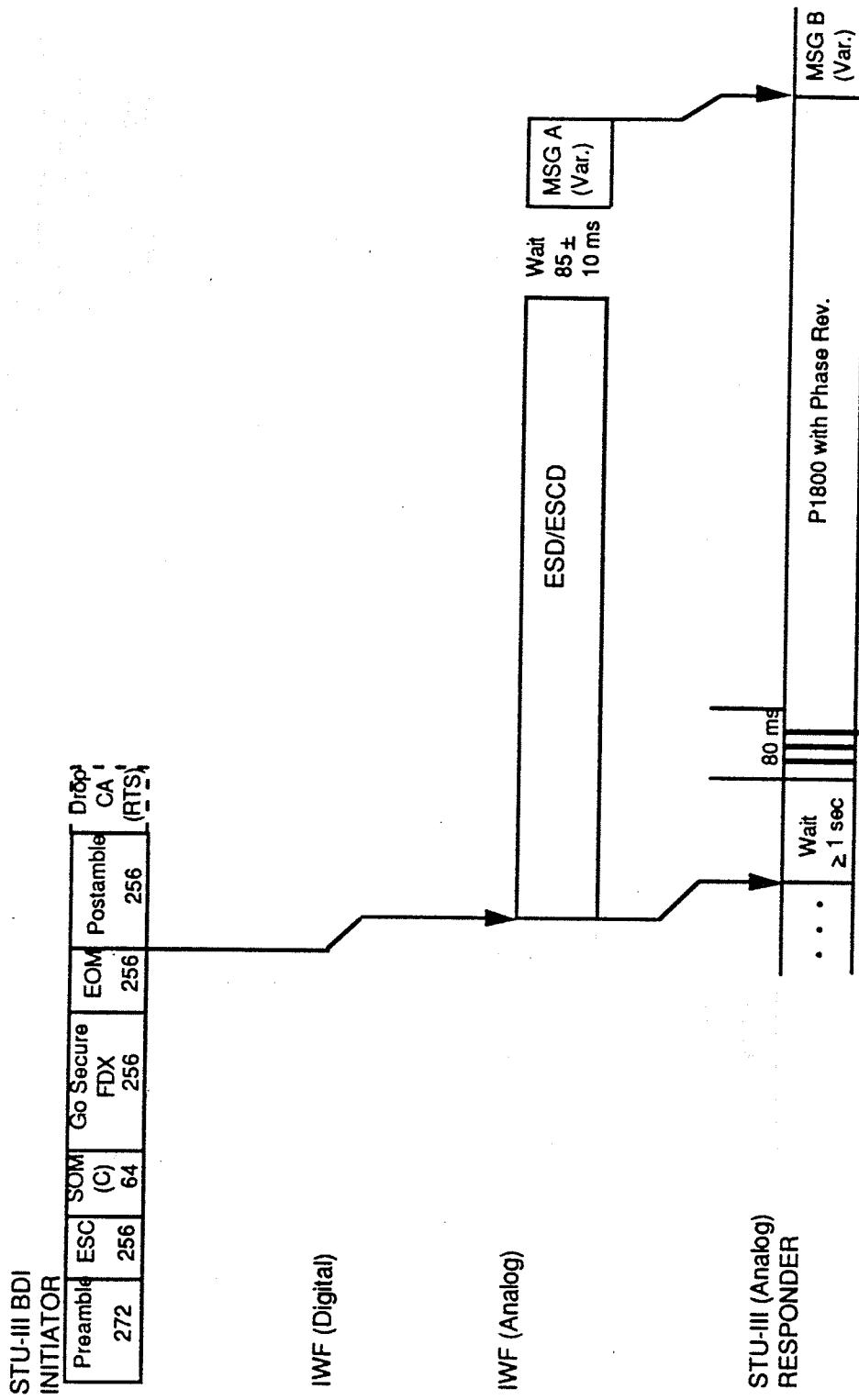


Figure 5.1.1.3.2-2 (a) IWF Full-Duplex Signaling for No Negotiated Rate Change with a STU-III BDI Initiator

Code	Equipment
43	Motorola Type I STU-III BDI Terminal
44	Motorola STU-III IWF
53	AT&T Type I STU-III BDI
54	AT&T STU-III IWF
63	Martin Marietta Type I STU-III BDI
64	Martin Marietta STU-III IWF

Table 4.3.5.1.1-1 STU-III BDI and IWF Numeric Product Codes

The options available for alert addressing allow the alerts to be used for point-to-point and dedicated alerting. These two types of alerting are described in the following sections.

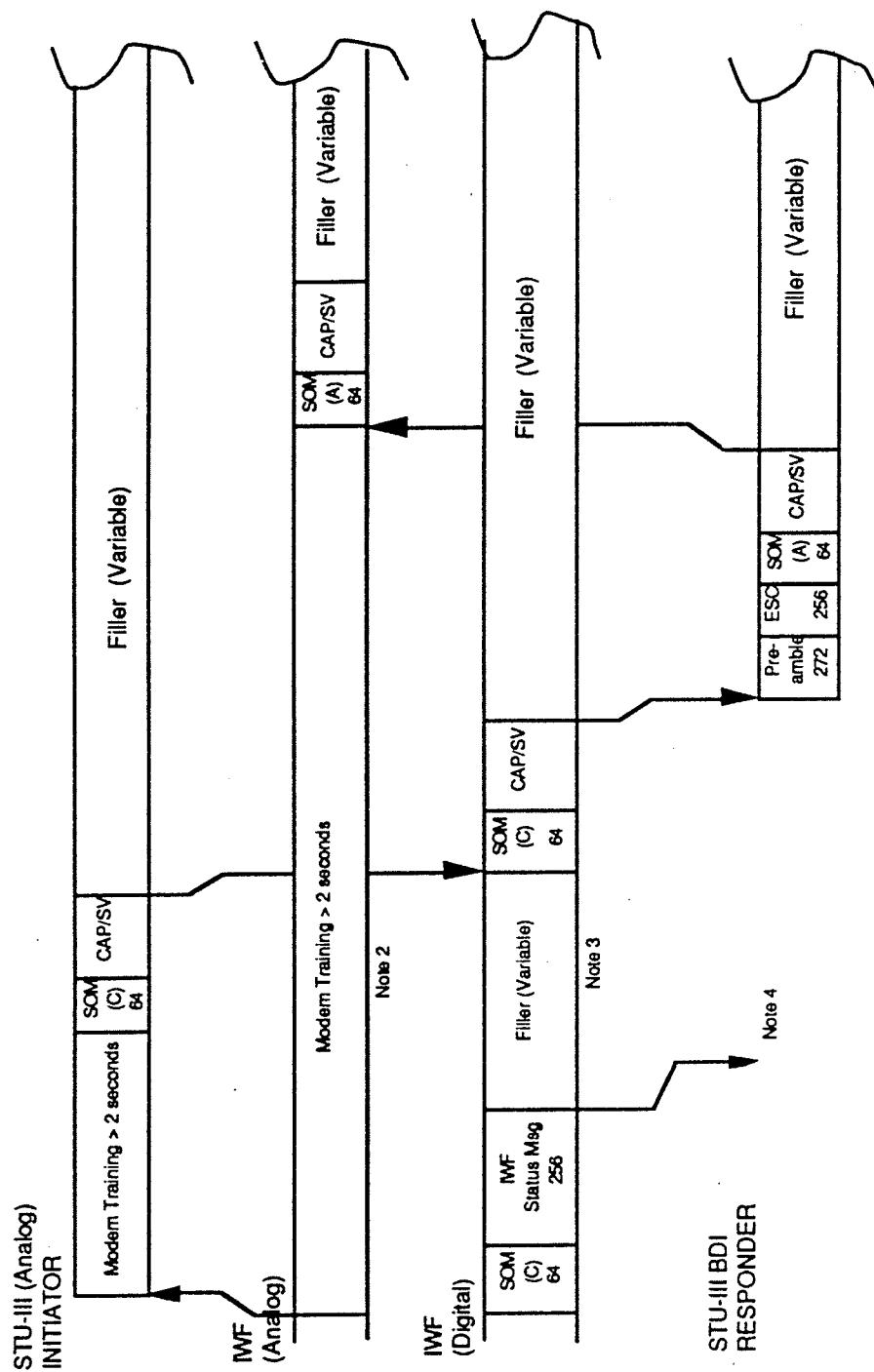
4.3.5.1.1.1 Point-to-Point Alerting (OC)

Point-to-point alerting shall be accomplished in a network using the source and destination addresses. In a logically or physically bussed network, all subscribers receive an alert transmission, but only the subscriber corresponding to the destination address shall respond to the alert. The STU-III BDI terminal shall examine the destination field of each alert it receives and ignore it if the address does not match the STU-III BDI terminal's dialing address. If it does match, then the STU-III BDI terminal shall respond accordingly.

If point-to-point alerting is to be used, the STU-III BDI terminal should be configured for switched operation.

4.3.5.1.1.2 Dedicated Alerting (MER)

If the network consists of only two subscribers, there is no need for the alert addresses. On this type of channel, the STU-III BDI terminal should be configured for dedicated operation. When the STU-III BDI terminal is configured as such, it shall not examine the destination address of received alerts, and shall respond to all received alerts. It shall also insert a "*" for each ASCII character in the destination address field of all alerts that it transmits. If a STU-III BDI terminal receives this type of alert and it is not configured for dedicated operation, it shall ignore the alert.



Note 2: The IWF transmits 64-bit increments of SCR1 (V.26) or B1 (V.32) sequence or filler (V.26 or V.32) until CAP/SV is received on the digital side. If the IWF receives CAP/SV prior to completion of modem training, it shall buffer the CAP/SV until modem training is completed.

- Note 3: Filler is rate dependent as follows:
 2 1472 total bits at 2400 bps,
 ≥ 2880 total bits at 4800 bps,
 ≥ 5760 total bits at 9600 bps,
 ≥ 8640 total bits at 14400 bps,
 ≥ 9600 total bits at 16000 bps,
 ≥ 19200 total bits at 32000 bps,
 prior to any bit-stuffing or error correction.

Note 4: If the BDI terminal is capable, it may transmit its CAP/SV to the IWF at this point. The IWF must then buffer the message until it has received the Secure Initiator's CAP/SV (if 2400 bps operation) or until modem training is complete (all other data rates). Upon the completion of transmission of CAP/SV a 20-second timer is set, waiting for receipt of the far-end's CAP/SV.

Figure 5.1.1.3.2-1 (b) IWF Full-Duplex Signaling for No Negotiated Rate Change with a STU-III BDI Responder (Cont.)

4.3.5.1.2 Alerting Scenarios

The following diagrams illustrate examples of alerting sequences in various scenarios. The diagrams will be referred to as communication threads and are sequentially ordered with time advancing downward. The interfaces are indicated at the top of the diagrams. Note that the black digital network, BDN, is used to describe any applicable digital network such as digital cellular, mobile satellite, etc. Messages are shown in an abbreviated format to convey only the pertinent information. Alerts are abbreviated as (Ring/Y n,m), where n is used to indicate the receiving terminal and m to indicate the transmitting terminal. The n and m do not imply that a BDI address exists within the message. Note the optional (OC) ACK message format is not shown. The communications threads do not show the frame transfer overhead such as RTS and CTS.

4.3.5.1.2.1 Switched Mode Alerting

4.3.5.1.2.1.1 Ring and Answer (MER - OC)

Table 4.3.5.1.2.1.1-1 illustrates the signaling for establishment of a point-to-point channel. Both STU-III BDI terminals must be configured for non-dedicated operation.

STU-III BDI #1	BDN	STU-III BDI #2
Go Off-Hook	----- Ring/Y 2,1 -----> <----- Ring ACK/Z 1,2 -----> <----- Off-Hook/Z 1,2 -----> ----- ACK 2,1 ----->	Go Off-Hook
Go On-Hook	----- On-Hook 2,1 -----> <----- ACK 1,2 ----->	Go On-Hook
<i>Table 4.3.5.1.2.1.1-1 Ring and Answer Thread</i>		

Following establishment of the channel, clear or secure call setup may be attempted. If a clear voice mode exists and the called terminal is not strapped for Auto Secure on Answer, then the clear voice mode will be entered automatically. When the secure mode is exited with the transmission of the Release, the On-Hook alert shall be sent.

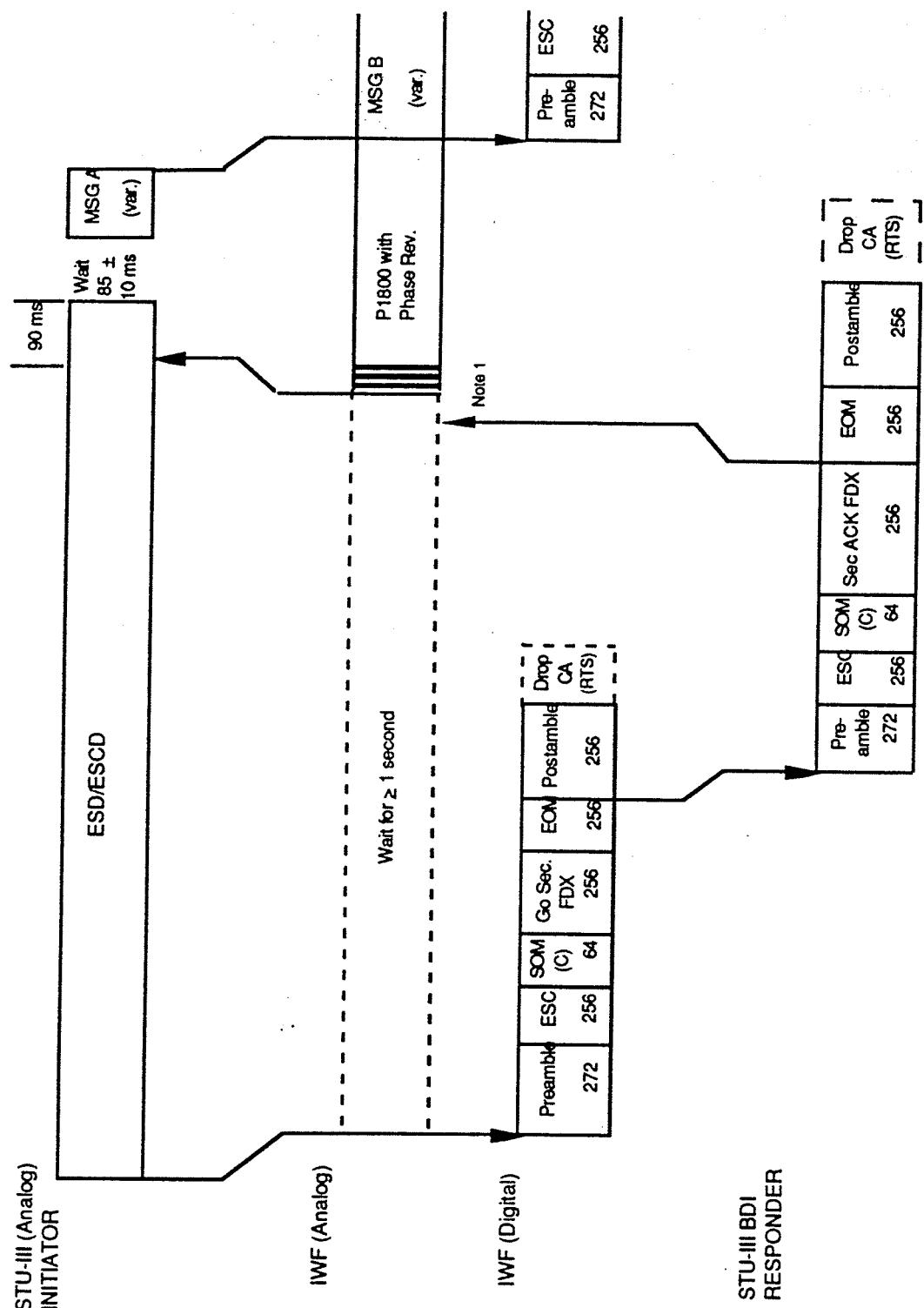


Figure 5.1.1.3.2-1 (a) IWF Full-Duplex Signaling for No Negotiated Rate Change with a STU-III BDI Responder

4.3.5.1.2.1.2 Ring Glare (MER - OC)

Table 4.3.5.1.2.1.2-1 illustrates the scenario in which two users, STU-III BDI #1 and STU-III BDI #2, ring each other simultaneously, resulting in a ring glare condition. Assuming the Ring/Y alert is received, the terminal with the lower address shall stop sending ring and wait. For this example, that terminal is STU-III BDI #2. The terminal with the higher address, STU-III BDI #1, shall stop sending ring to the far-end, and transmit an Off-Hook/Z in response to the received Ring/Y.

In addition, when two terminals, A and B, are communicating and a third terminal, C, interrupts with Ring/Y to terminal A, terminal A shall either transmit a Busy to terminal C or ignore the incoming Ring/Y alert.

STU-III BDI #1	BDN	STU-III BDI #2
Go Off-Hook Stops sending ring and sends Off-Hook /Z.	- Ring/Y 2,1 - ->-- Ring/Y 1,2 - ----- Off-Hook/Z 2,1 -----> <----- ACK 1,2 -----> . <----- On-Hook 1,2 -----> ----- ACK 2,1 ----->	Go Off-Hook Stops sending ring and waits.
Go On-Hook		Go On-Hook

Table 4.3.5.1.2.1.2-1 Ring Glare Thread

4.3.5.1.2.1.3 Address Busy (MER - OC)

Table 4.3.5.1.2.1.3-1 illustrates the scenario in which the dialed address is busy or unavailable. In this scenario, a Busy is sent in response to the Ring/Y, and the dialing terminal then goes on-hook. The On-Hook message shall not be sent. In many situations, the busy terminal is unable to send the Busy message, in which case the calling terminal shall timeout 3.3 seconds (ten seconds for extended mode) after its third retransmission attempt of the Ring/Y message.

5.1.1.3.2 Signaling for No Negotiated Rate Change (MER)

The scenarios presented in Figures 5.1.1.3.2-1 and 5.1.1.3.2-2 illustrate the signaling protocol when the Message A/B rate negotiation results in no rate change on the digital side. Signaling occurs similarly to that specified in Section 5.1.1.3.1, with the exclusion of the new rate messaging beginning at the filler after the IWF Status message. Since there is no Circuit CH rate change, the Preamble and Escape before the SOM(A) and CAP/SV shall not be transmitted from the IWF digital side.

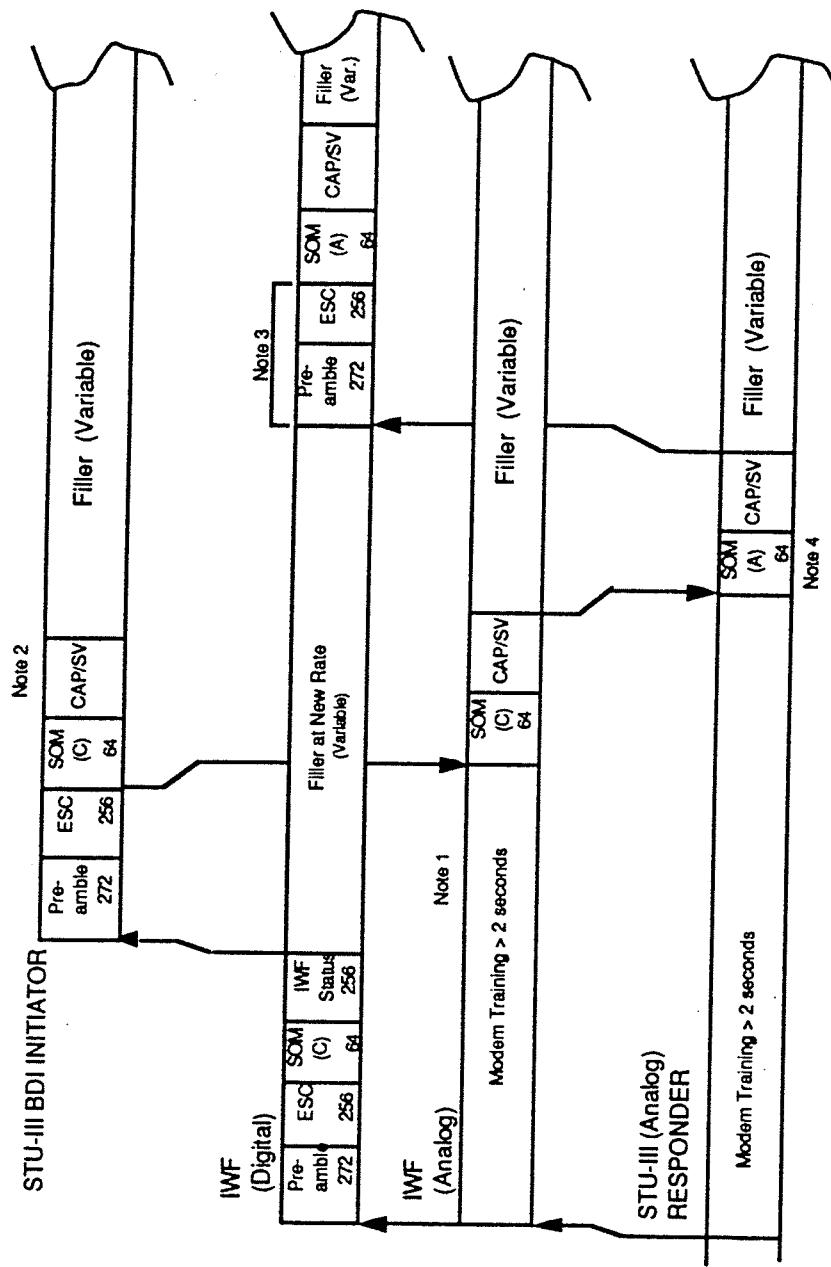
STU-III BDI #1	BDN	STU-III BDI #2
Go Off-Hook	- - - - - Ring/Y 2,1 - - - - -> < - - - - - Busy 1,2 - - - - -	
Go On-Hook		

Table 4.3.5.1.2.1.3-1 Address Busy Thread

4.3.5.1.2.1.4 Auto-Secure STU-III BDI (MER - OC)

Table 4.3.5.1.2.1.4-1 illustrates a point-to-point call establishment, with a STU-III BDI terminal configured for auto-secure on answer, full-duplex mode. If there are other non-STU-III BDI subscribers on the network and they attempt to use the channel, the secure call setup will fail.

When STU-III BDI terminal #2 has initiated a secure call and begins transmitting Mode Msg A, it shall seize its transmit channel and hold it throughout the duration of the secure call. Likewise, when STU-III BDI terminal #1 begins secure signaling with Secure Ack, it shall seize its transmit channel and hold it until secure completion.



Note 1: The IWF transmits 64 bit increments of SCR1 (V.28) or B1 (V.32) sequence or filler (V.26 or V.32) until CAP/SV is received on the digital side. If the IWF receives CAP/SV prior to completion of modem training, it shall buffer the CAP/SV until modem training is completed.

Note 2: STU-III BDI starts 20 sec. timer upon transmission of CAP/SV, waiting for CAP/SV.

Note 3: These messages will only be sent if there is a circuit CH rate change.

Note 4: When modem training occurs at 4800 or 9600 bps, the analog STU-III will not wait for the arrival of the far-end terminal's CAP/SV, but rather will transmit its own CAP/SV as soon as modem training has been completed.

Figure 5.1.1.3.1-2 (b) IWF Full-Duplex Signaling for a Negotiated Rate Change with a STU-III BDI Initiator (Cont.)

STU-III BDI #1	BDN	STU-III BDI #2
Go Off-Hook (User Prompt)	----- Ring/Y 2,1 -----> <----- Ring ACK/Z 1,2 -----> <----- Off-Hook/Z 1,2 -----> ----- ACK 2,1 -----> <----- Go Secure FDX -----> ----- Secure ACK FDX -----> <----- Mode Message A -----> ----- Mode Message B -----> <----- CAP/SV -----> ----- CAP/SV -----> . .	Go Off-Hook Go Secure

Table 4.3.5.1.2.1.4-1 Auto-Secure Thread

4.3.5.1.2.2 Dedicated Mode Alerting (MER - OC)

Table 4.3.5.1.2.2-1 illustrates a dedicated alert sequence. The "*" symbol indicates a dedicated alert. Messages other than ACK will insert ASCII "*"s in their destination address; however, the STU-III BDI does not actually recognize the "*" as the destination; it is configured for dedicated operation, so it ignores the address.

In the event of a ring glare condition, both terminals shall stop sending ring. Since the source addresses are exchanged in dedicated mode, the ring glare condition shall be resolved as specified in section 4.3.5.1.2.1.2 for switched mode alerting.

4.3.5.1.2.3 Retransmission of Alerting Messages (MER - OC)

In point-to-point and dedicated alerting, each alert shall be acknowledged. If an acknowledgment is not received within a timeout period, the alert shall be retransmitted. After three unacknowledged retransmission attempts, the transmitter shall revert to the on-hook state, transmitting an On-Hook alert, if appropriate, and notify its user. This section specifies scenarios

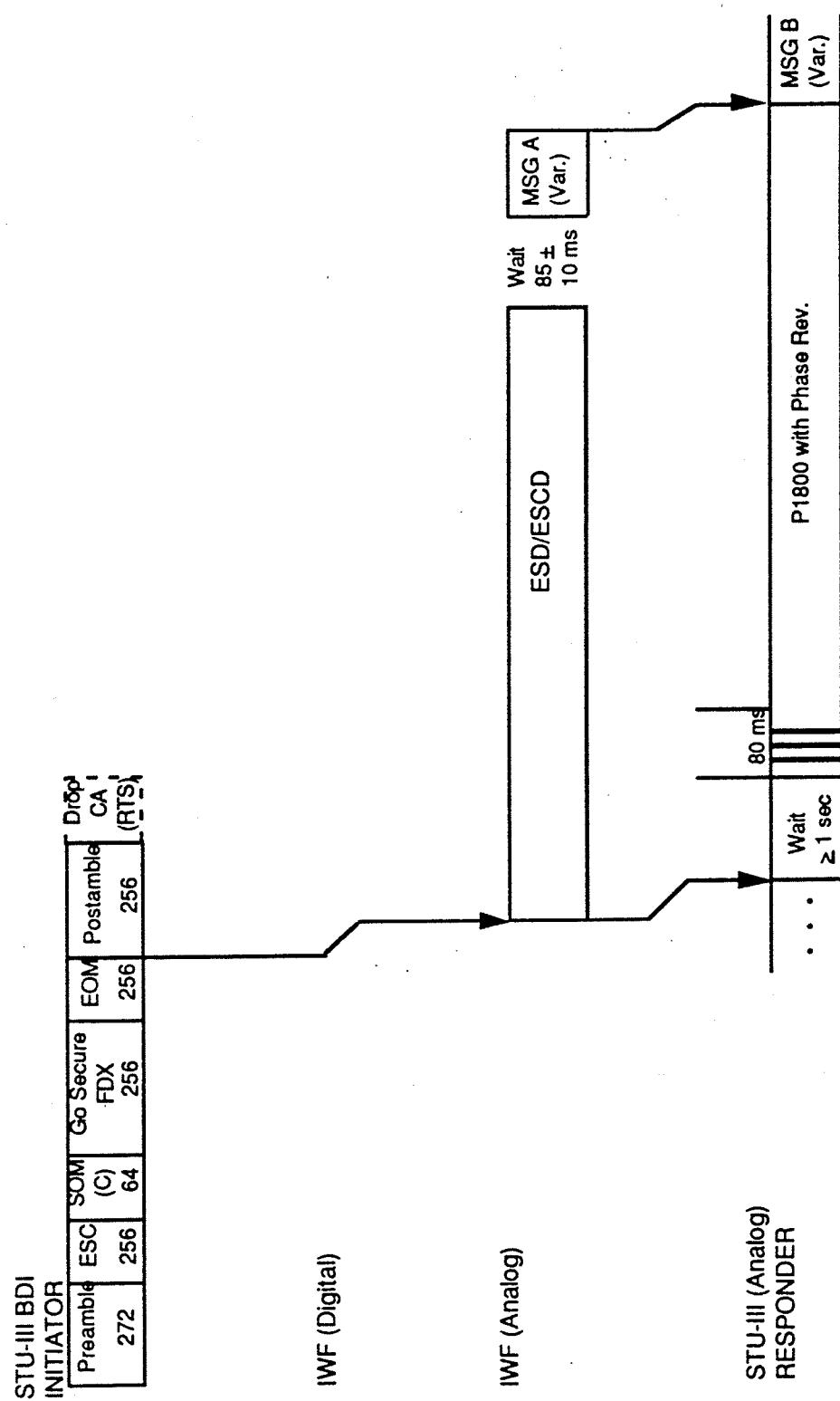


Figure 5.1.13.1-2 (a) IWF Full-Duplex Signaling for a Negotiated Rate Change with a STU-III BDI Initiator

in which alerts are corrupted and must be retransmitted. Examples are provided for Ring/Y and Off-Hook/Z corruption. Other alerting scenarios are similar.

STU-III BDI #1	BDN	STU-III BDI #2
Go Off-Hook	----- Ring/Y *,1 -----> <----- Ring ACK/Z *,2 -----> <----- Off-Hook/Z *,2 -----> ----- ACK *,1 -----> . . . ----- On-Hook *,1 -----> <----- ACK *,2 ----->	Go Off-Hook
Go On-Hook		Go On-Hook

Table 4.3.5.1.2.2-1 Dedicated Mode Alerting Thread

4.3.5.1.2.3.1 Ring Corruption (MER - OC)

Table 4.3.5.1.2.3.1-1 illustrates a scenario in which the first Ring/Y alert is corrupted and STU-III BDI #2 does not detect it. STU-III BDI #1 shall time out and retransmit the Ring/Y. Next, assume the Ring ACK/Z is corrupted. STU-III BDI #2 sends the Off-Hook/Z alert before STU-III BDI #1 times out a second time. Instead of retransmitting the Ring/Y for a third time, STU-III BDI #1 shall accept the Off-Hook/Z Message as the acknowledgment, as shown in the table.

STU-III BDI #1	BDN	STU-III BDI #2
Go Off-Hook (Timeout)	----- XXXXXXXXXXXX ----->	
Send Ring/Y Again	----- Ring/Y 2,1 -----> <----- XXXXXXXXXXXX -----> <----- Off-Hook/Z 1,2 -----> ----- ACK 2,1 ----->	Send Ring ACK/Z Go Off-Hook

Table 4.3.5.1.2.3.1-1 Poor-Channel Alerting Thread—Ring Corruption

In Figure 5.1.1.3.1-2 (a and b), the STU-III BDI is the Secure Initiator. The Interworking Function must now recognize the presence of phase reversals in the P1800 Hz signal. The mapping of messages is analogous to that in the first example.

4.3.5.1.2.3.2.2 Off-Hook Corruption (MER - OC)

Table 4.3.5.1.2.3.2-1 illustrates the case in which channel fading causes the Off-Hook/Z alert to be corrupted four times so that it never gets acknowledged. After the fourth timeout, STU-III BDI #2 shall timeout, send the On-Hook alert, and go on-hook. STU-III BDI #1 never saw STU-III BDI #2's Off-Hook alert, but instead receives the On-Hook alert. STU-III BDI #1 shall ACK the On-Hook alert.

STU-III BDI #1	BDN	STU-III BDI #2
Go Off-Hook	----- Ring/Y 2,1 -----> <----- Ring ACK/Z 1,2 -----> <--- XXXXXXXXXXXX- ---> <--- XXXXXXXXXXXX ---> <--- XXXXXXXXXXXX ---> <--- XXXXXXXXXXXX ---> <----- On-Hook 1,2 -----> ----- Ack 2,1 ----->	Go Off-Hook (Timeout), send Off-Hook/Z Again. (Timeout), send Off-Hook/Z Again. (Timeout), send Off-Hook/Z Again. (Timeout & Reset) Go On-Hook
Go On-Hook		

Table 4.3.5.1.2.3.2-1 Poor-Channel Alerting Thread—Off-Hook Corruption

4.3.5.2 Clear Mode Messages

4.3.5.2.1 Clear Call Setup Messages (MER - OC)

In general there are three types of messages relating to clear call setup: Capability Exchange, Mode Control, and Miscellaneous Control messages. The Capability Exchange messages indicate the capabilities and modes supported by the terminals in clear mode operation. They are exchanged during alerting, prior to clear call initiation. The Clear Mode Control messages are utilized in negotiating a common clear mode from the alerting idle state. The

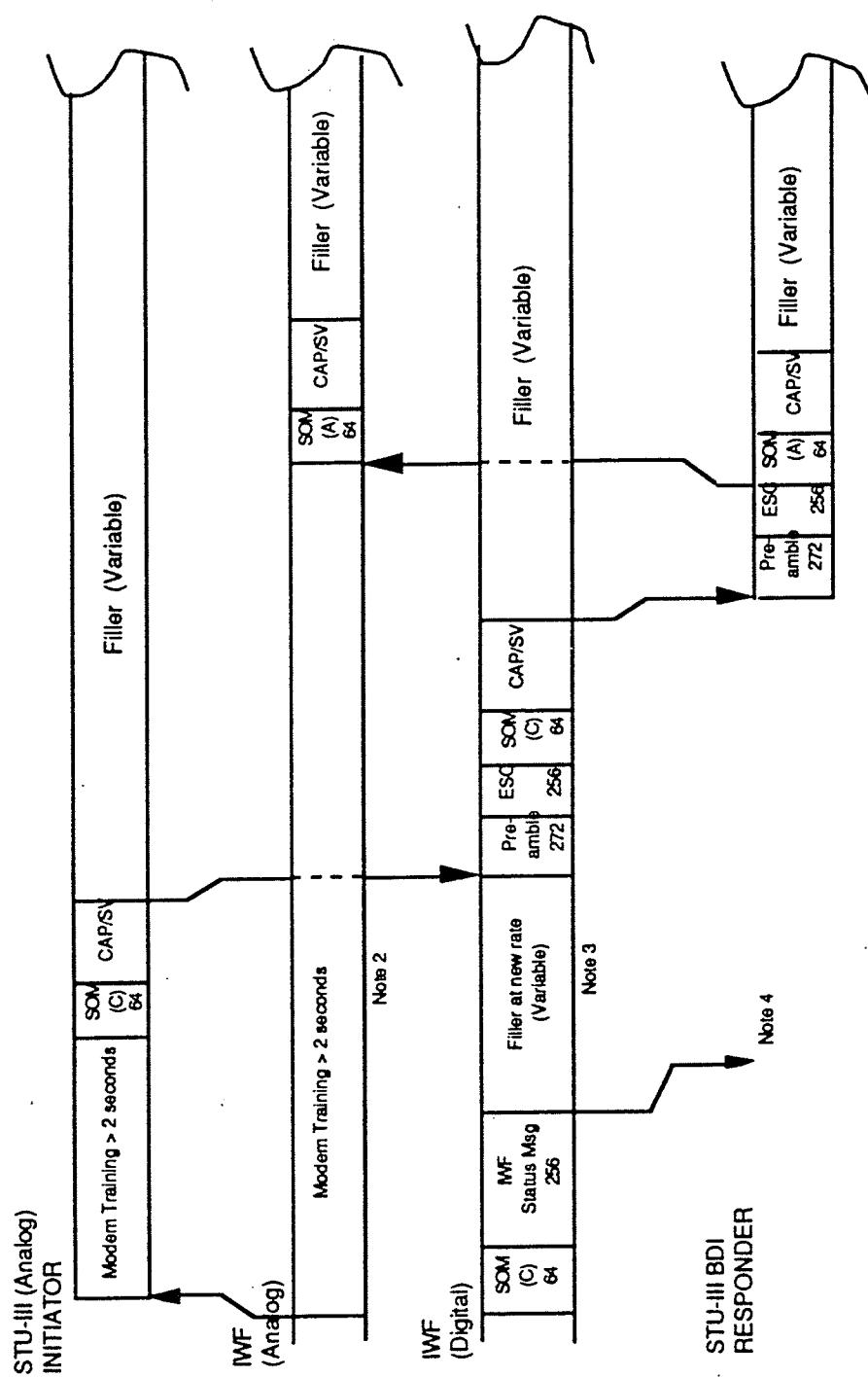


Figure 5.1.1.3.1-1 (b) IWF Full-Duplex Signaling for a Negotiated Rate Change with a STU-III BDI Responder (Cont.)

Miscellaneous Control messages provide control for alternative operation in cases where an additional feature, not part of the standard signaling, is needed in the clear mode. The Miscellaneous Control messages are Optional Capabilities (OCs), which are exceptions to the required signaling.

The first terminal to initiate the clear call sequence will assume the role of "Clear Initiator"; the other terminal assumes the role of "Clear Responder". All clear call setup signaling shall be scrambled, using the GPC scrambler, and shall use the Initiator SOM, SOM(C), (as defined in FSVS-210) for both Clear Initiator and Clear Responder signaling. Note that the Clear Initiator and Clear Responder designations will not necessarily apply to the same terminal as the Secure Initiator and Secure Responder, respectively.

4.3.5.2.1.1 Clear Mode Capability Exchange Messages (MER)

In order to support clear modes of operation, an exchange of clear mode capabilities shall be required between the two communicating terminals, prior to the start of clear call signaling over a digital channel. This is accomplished by the exchange of the Y and Z messages. The defined Y and Z Messages shall contain a BDI rate byte indicating the supported BDI line rate, and if the circuit CH rate change capability is supported, an additional bit to indicate the corresponding lower rate that the circuit CH change will select. (This byte is not intended to negotiate a BDI rate, but rather to inform the receiving terminal of the current configuration of the sending BDI terminal.) Also included in the Y and Z messages are all the clear mode capabilities supported by the initiating and responding STU-III BDI terminals, respectively, as well as a secure capabilities byte as defined in Section 4.3.6.1.1.1. The Y Message shall always be sent in the alerting Ring/Y message. The Z Message shall always be sent in the alerting Ring ACK/Z and the Off-Hook/Z messages.

The Y and Z Messages shall be sent as the second BCH block in the Ring/Y, Ring ACK/Z, and the Off-Hook/Z messages, respectively. The Y Message shall contain bits set (binary "1") for all capabilities corresponding to current terminal settings. Since the Y and Z Messages are exchanged during alerting, the Z Message differs from the convention of Mode Message B in secure operation. The Z Message shall also contain bits set (binary "1") for all capabilities corresponding to current terminal settings. The operational mode is selected as specified in Section 4.3.5.2.1.3. The format of the Y and Z Messages is shown in Figure 4.3.5.2.1.1-1. The information contents are specified in Table 4.3.5.2.1.1-1.

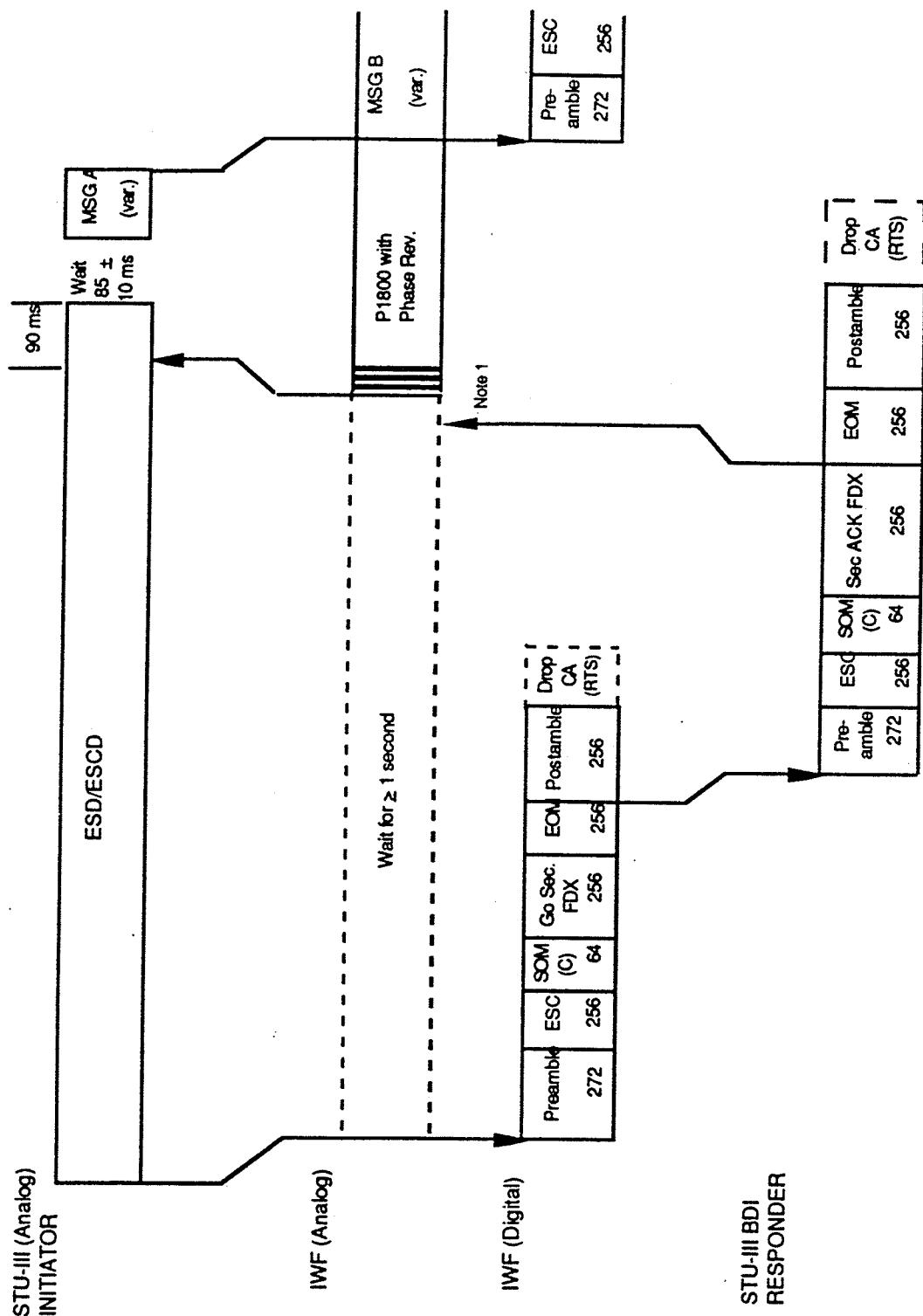


Figure 5.1.1.3.1-1 (a) IWF Full-Duplex Signaling for a Negotiated Rate Change with a STU-III BDI Responder

Message Y or Z 128 bits (16 bytes)	Parity 128 bits (16 bytes) for BCH block
---------------------------------------	---

Message Y and Z - as defined in Table 4.3.5.2.1.1-1

*Figure 4.3.5.2.1.1-1 Y and Z Message Format - Second BCH Block in the Ring/Y, Ring ACK/Z,
or Off-Hook/Z Alerting Message*

Location	Function
Byte 1 bit 0 (lsb)	extensibility bit (as defined in FSFS-210, always set to 1)
Byte 1 bit 1	2400 bps BDI line rate
Byte 1 bit 2	4800 bps BDI line rate
Byte 1 bit 3	9600 bps BDI line rate
Byte 1 bit 4	14400 bps BDI line rate
Byte 1 bit 5	16000 bps BDI line rate
Byte 1 bit 6	32000 bps BDI line rate
Byte 1 bit 7	BDI Duplex bit (1=HDX; 0=FDX)
Byte 2 bit 0 (lsb)	extensibility bit (as defined in FSFS-210, always set to 1)
Byte 2 bit 1	LPC-10e vocoder, 2400 bps HDX clear voice mode
Byte 2 bit 2	CELP vocoder, 4800 bps HDX clear voice mode
Byte 2 bit 3	RCELP vocoder, 4800 bps HDX clear voice mode
Byte 2 bit 4	MREL P vocoder, 9600 bps HDX clear voice mode
Byte 2 bit 5	CVSD vocoder, 16000 bps HDX clear voice mode
Byte 2 bit 6	CVSD vocoder, 32000 bps HDX clear voice mode
Byte 2 bit 7	reserved, transmit zero
Byte 3 bit 0 (lsb)	extensibility bit (as defined in FSFS-210, always set to 1)
Byte 3 bit 1	LPC-10e vocoder, 2400 bps FDX clear voice mode
Byte 3 bit 2	CELP vocoder, 4800 bps FDX clear voice mode
Byte 3 bit 3	RCELP vocoder, 4800 bps FDX clear voice mode

Table 4.3.5.2.1.1-1 (a) Y and Z Message Contents

Location	Function
Byte 3 bit 4	MREL P vocoder, 9600 bps FDX clear voice mode
Byte 3 bit 5	CVSD vocoder, 16000 bps FDX clear voice mode
Byte 3 bit 6	CVSD vocoder, 32000 bps FDX clear voice mode
Byte 3 bit 7	reserved, transmit zero
Byte 4 bit 0 (lsb)	extensibility bit (as defined in FSVS-210, always set to 1)
Byte 4 bits 1	2400 bps HDX clear data mode
Byte 4 bits 2	4800 bps HDX clear data mode
Byte 4 bits 3	9600 bps HDX clear data mode
Byte 4 bits 4	14400 bps HDX clear data mode
Byte 4 bits 5	16000 bps HDX clear data mode
Byte 4 bits 6	32000 bps HDX clear data mode
Byte 4 bits 7	reserved, transmit zero
Byte 5 bit 0 (lsb)	extensibility bit (as defined in FSVS-210, always set to 1)
Byte 5 bits 1	2400 bps FDX clear data mode
Byte 5 bits 2	4800 bps FDX clear data mode
Byte 5 bits 3	9600 bps FDX clear data mode
Byte 5 bits 4	14400 bps FDX clear data mode
Byte 5 bits 5	16000 bps FDX clear data mode
Byte 5 bits 6	32000 bps FDX clear data mode
Byte 5 bits 7	reserved, transmit zero
Byte 6 bit 0 (lsb)	extensibility bit (as defined in FSVS-210, always set to 1)
Byte 6 bits 1	1 = Terminal is IWF; 0 = Terminal is not an IWF
Byte 6 bits 2	supports circuit CH rate change capability
Byte 6 bits 3-7	reserved, transmit zeros

Table 4.3.5.2.1.1-1 (b) Y and Z Message Contents (Cont.)

5.1.1.2.6 Clear Voice Modes (MER - OC)

If clear voice modes are supported, the IWF may support any or all of the vocoders listed in Table 4.3.5.4-1 that are supported by the STU-III BDI terminals connected to the digital network. The IWF shall also support conversion from vocoder data to analog voice, 64 kbps PCM voice signals, or other formats as required.

5.1.1.3 Secure Call Setup (MER)

Signaling at the Interworking Function is defined such that a STU-III BDI and an analog STU-III communicate with each other as though they were each communicating with a terminal of the same type. The figures and descriptions presented in this section illustrate the required signaling. These scenarios show the analog/digital mapping between secure mode control messages and various signaling tones.

5.1.1.3.1 Signaling for a Negotiated Rate Change (MER)

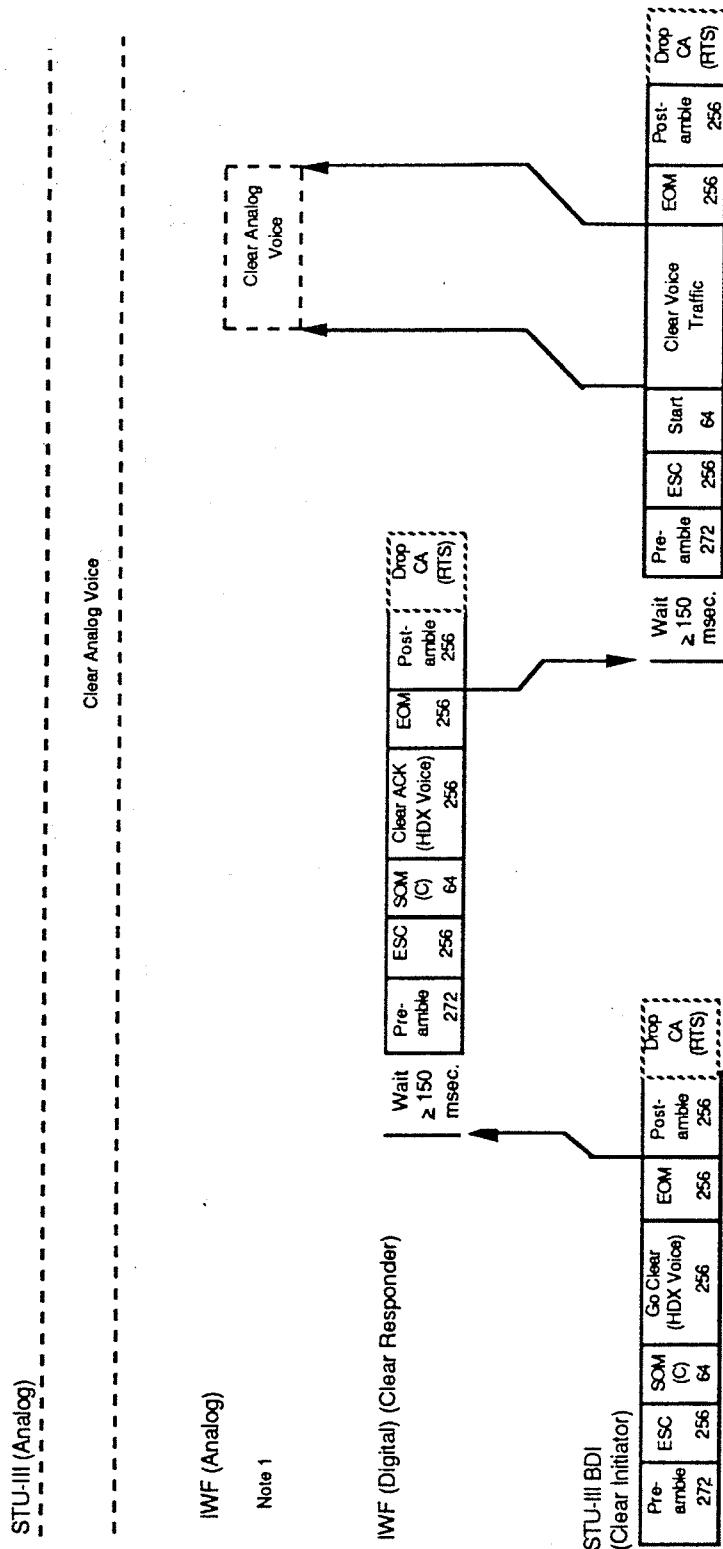
The STU-III Message A/B and STU-III BDI pre-staging/IWF Status message exchanges provide the means to negotiate a common information rate for subsequent signaling and traffic. The diagrams below illustrate the signaling protocol when the negotiation results in a BDI rate change, whether it is through rate adaption, a different BDI line rate, or both. Note that the signaling prior to the (Mode) Message A/B exchange may be at different rates on the digital and analog sides. The rate negotiation determines the common information rate to be used for secure traffic. STU-III BDI signaling shall always start at the BDI line rate with no rate adaption.

In Figure 5.1.1.3.1-1, the PSTN STU-III first goes secure, thus becoming the Initiator. It sends an ESD/ESCD signal, which the IWF shall map into a *Go Secure Full-Duplex* digital control message. The STU-III BDI receives this, and responds with a *Secure ACK FDX* digital control message. Note that a STU-III BDI Responder always offers alternate modes with the *Secure ACK FDX* message; this is described below and in Section 4.3.6.1.1.1.

The Interworking Function detects the *Secure ACK FDX* message, optionally performs BCH error detection and correction, and interprets the message. In this case, the IWF shall wait for the minimum one second analog side delay (but will not wait to receive the *Secure ACK* message) and then send a Pseudo 1800 Hz signal with phase reversals. The IWF shall transmit

Location	Function
Byte 7 bit 0 (lsb)	extensibility bit (as defined in FSVS-210, always set to 1)
Byte 7 bits 1	Supports Dial Number Message
Byte 7 bits 2	Supports Tone Passthrough Message
Byte 7 bits 3	Supports Exception Message
Byte 7 bits 4	Supports Predefined Message
Byte 7 bits 5	Supports Secure Capabilities Message
Byte 7 bits 6-7	reserved, transmit zeros
Byte 8 bit 0 (lsb)	extensibility bit (as defined in FSVS-210, always set to 1)
Byte 8 bits 1-7	Reserved for STE interoperability, transmit zeros
Byte 9 bit 0 (lsb)	extensibility bit (as defined in FSVS-210)
Byte 9 bits 1-7	Secure Capabilities Codeword
Byte 10 bit 0 (lsb)	extensibility bit (as defined in FSVS-210)
Byte 10 bits 1-7	Motorola Proprietary bits
Byte 11 bit 0 (lsb)	extensibility bit (as defined in FSVS-210)
Byte 11 bits 1-7	Martin Marietta Proprietary bits
Byte 12 bit 0 (lsb)	extensibility bit (as defined in FSVS-210)
Byte 12 bits 1-7	Martin Marietta Proprietary bits
Byte 13 bit 0 (lsb)	extensibility bit (as defined in FSVS-210)
Byte 13 bits 1-7	AT&T Proprietary bits
Byte 14 bit 0 (lsb)	extensibility bit (as defined in FSVS-210)
Byte 14 bits 1-7	AT&T Proprietary bits
Byte 15 bit 0 (lsb)	extensibility bit (as defined in FSVS-210)
Byte 15 bits 1-7	Motorola Proprietary bits
Byte 16 bits 1-7	reserved, transmit zeros
Byte 16 bit 0 (lsb)	BCH block extension

Table 4.3.5.2.1.1-1 (c) Y and Z Message Contents (Cont.)



Note 1: The signaling shown in Figure 5.1.1.2-4-2 (a through c) precedes this diagram.

Figure 5.1.1.2-5-2 Half-Duplex Clear Mode Signaling for an Analog STU-III Calling a STU-III BDI

4.3.5.2.1.2 Miscellaneous Control Messages (OC)

Miscellaneous Control messages are required for certain nonstandard signaling. They are listed in Table 4.3.5.2.1.2-1. They are Optional Capabilities (OCs) sent during the clear call mode, but may also be sent during the secure call mode, such as the Exception and Predefined messages. Miscellaneous Control messages shall always be transmitted in complete BCH blocks and scrambled, using the GPC scrambler when transmitted by either the Clear Initiator or Clear Responder terminal. All Miscellaneous Control messages shall be preceded by the Initiator SOM, SOM(C), even if transmitted by the Clear Responder.

Message	MID (Hex)
Tone Passthrough Message	2011
Dial Number Message	2022
Predefined Message	20AA
Exception Message	2077
Secure Capabilities Message	2088

Table 4.3.5.2.1.2-1 Miscellaneous Control Messages

Tone Passthrough Message (OC)

The Tone Passthrough Message shall be used to pass telephone network signaling information from the IWF to a STU-III BDI terminal. In a normal telephone call several tones are interpreted by the calling party (Busy, Fast Busy, Ringback, etc.). Since these tones may vary from country to country, a generic tone detector is defined on the IWF side allowing the STU-III BDI terminal to interpret the signals by table look-up and provide a display and/or synthesize the tones based on this digital message. The Tone Passthrough Message shall be an Optional Capability, (OC), indicated in the Y and Z Messages exchanged during alerting.

The Tone Passthrough Message shall consist of one BCH block containing an MID followed by 14 ASCII characters formatted as shown in Figure 4.3.5.2.1.2-1. The occurrence count specifies the number of generations of the tone or tones identified by the frequency #1 and #2 fields. An occurrence count of 'TF' shall be used to indicate that an additional Tone Passthrough message follows. Actual tone generation shall not begin until the entire sequence has been received. A numeric occurrence count shall indicate the final Tone Passthrough

STU-III BDI (Clear Responder)

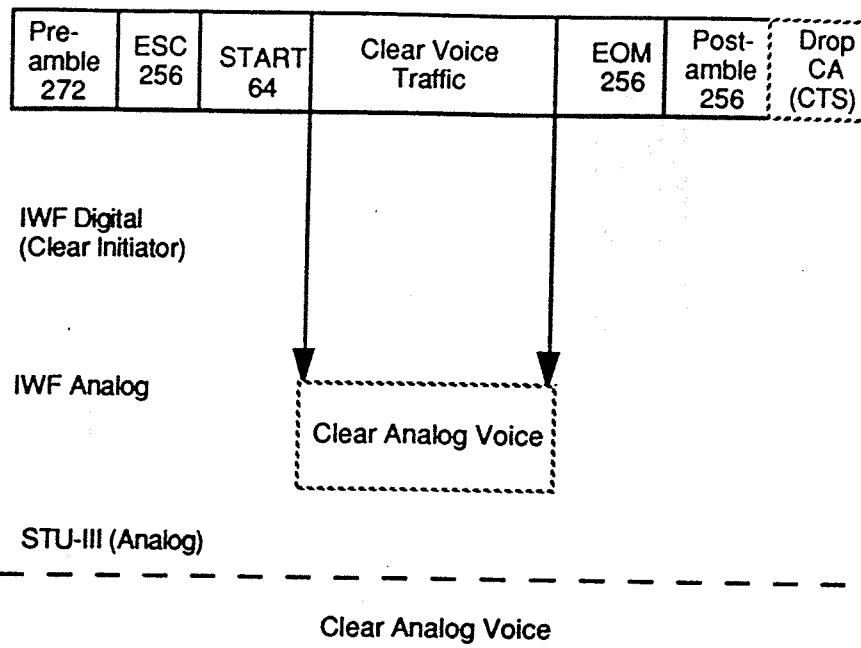


Figure 5.1.1.2.5-1 (c) Half-Duplex Clear Mode Signaling for a STU-III BDI Calling an Analog STU-III (Cont.)

message of the entire sequence. A maximum of four sequential Tone Passthrough messages may be sent at any given time.

MID 16 bits	Frequency #1 (4 bytes)	Frequency #2 (4 bytes)	Time On (2 bytes)	Time Off (2 bytes)	Occurrence Count (2 bytes)
----------------	---------------------------	---------------------------	----------------------	-----------------------	----------------------------------

MID - 2011 hex

Frequency #1 - four digits indicating a frequency between 300 Hz and 3000 Hz, e.g.

0440 = 440 Hz

Frequency #2 - four digits indicating a frequency between 300 Hz and 3000 Hz, e.g.

1300 = 1300 Hz

Time On - 0 to 9.9 seconds in 100 msec increments, 00 = tone off

Time Off - 0 to 9.9 seconds in 100 msec increments, 00 = tone off

Occurrence Count - number of occurrences of the defined signal, 99 = continuous, 00 = stop signal, (used to stop a previously sent continuous signal set with a 99), 'TF' = indicates that an additional Tone Passthrough message follows

Figure 4.3.5.2.1.2-1 Tone Passthrough Message Format

Dial Number Message (OC)

The Dial Number Message is intended for applications in which two-stage dialing is required to communicate from a STU-III BDI terminal to analog STU-III via an IWF. The Dial Number Message shall be an Optional Capability, (OC), indicated in the Y and Z Messages during alerting. The format for the Dial Number Message is shown in Figure 4.3.5.2.1.2-2.

The Dial Number Message shall be sent from the STU-III BDI terminal to the IWF. It shall contain digits to be dialed on the PSTN by the IWF. The message consists of an MID followed by a one byte Sequence Number and the number to be dialed. The Sequence Number shall indicate the order of transmission of multiple Dial Number messages sent in a sequence; i.e. a Sequence Number of "1" shall be assigned to the first Dial Number message in a sequence, while a "2" shall be assigned to the second message, etc. The Sequence Number shall begin with

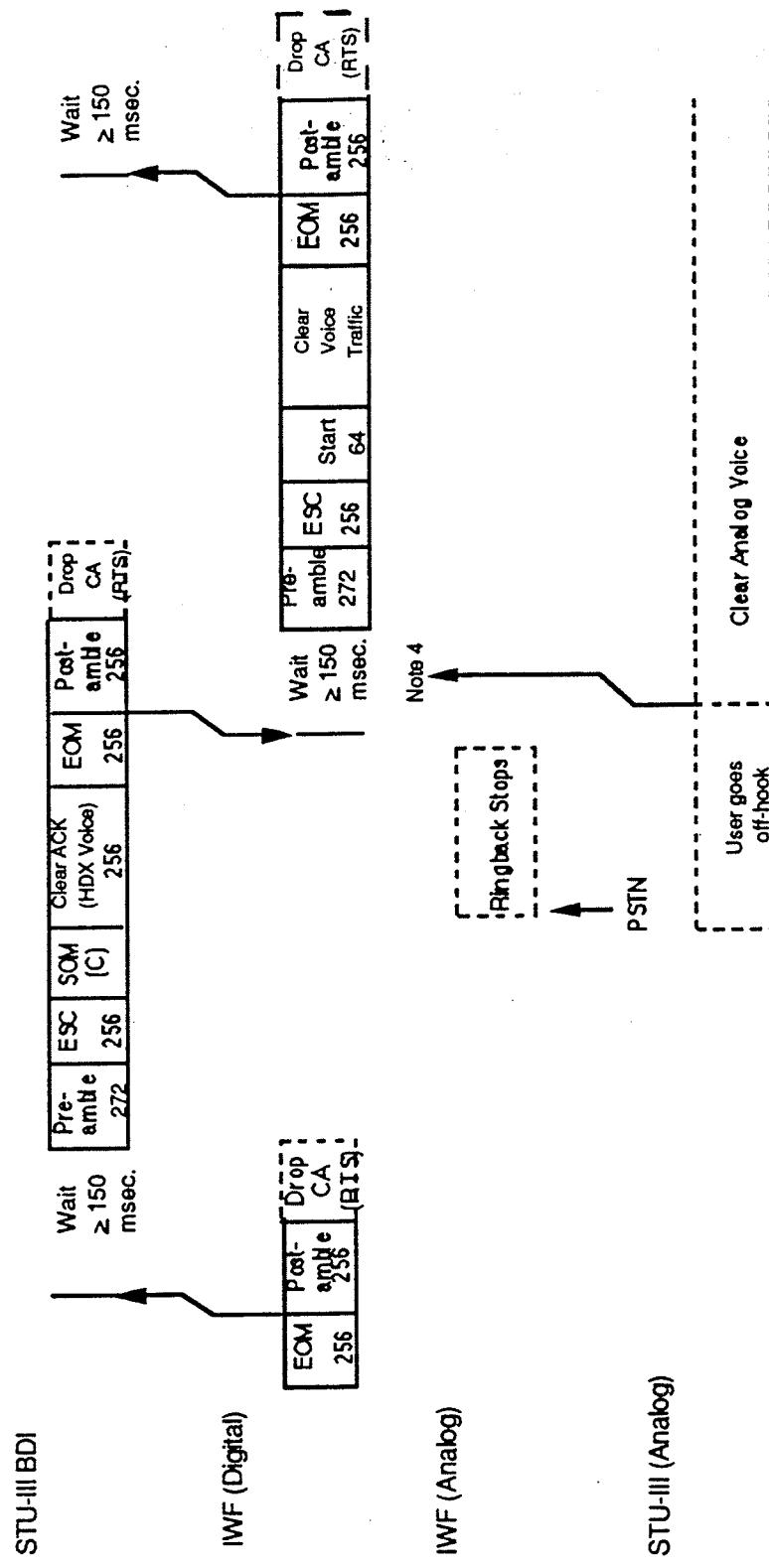


Figure 5.1.12.5-1 (b) Half-Duplex Clear Mode Signaling for a STU-III BDI Calling an Analog STU-III (Cont.)

a "1" at the beginning of each new call. If more than ten dial numbers are to be sent, the sequence numbers shall be "1 2 3 4 5 6 7 8 9 0 1 2 3 ...".

MID	Sequence No.	Dial Number	Unused Data Field	Parity
16 bits	8 bits	x bytes	y bytes	16 bytes (128 bits)

MID - 2022 hex

Sequence Number - contains ASCII character digits corresponding to the number of the Dial Number message in the sequence

Dial Number - contains ASCII text dial digit characters, $x < 14$

Unused Data Field - remaining bytes not used for dial digits, set to " ", space, $x+y=13$ bytes

Parity - for the BCH block encoding

Figure 4.3.5.2.1.2-2 Dial Number Message Format

The following 13 bytes in the data field shall contain from 1 to 13 ASCII characters from the set, {0123456789#*TP,HABCDRE}, representing dial digits. These characters are defined in a manner similar to the Hayes dial command (ATD) set. They include "T" for Tone, "P" for Pulse, "," for Pause, "H" for Hookflash, etc. The characters A, B, C, and D shall be used for the AUTOVON precedence indicators "FO" (Flash Override), "F" (Flash), "I" (Immediate), and "P" (Priority), respectively. The character "R" shall indicate a "Hookswitch Reset", and "E" shall indicate "End of Dialing". All unused bytes shall be set to the " " (space) character.

Predefined Message (OC)

The Predefined Message capability provides a general purpose clear mode message transfer capability for the STU-III BDI terminal and IWF. ASCII text in the BCH block data field shall be used to relay the message content. The message shall contain predefined call status information from the transmitting terminal to the receiving terminal; it is not intended for user specified messages entered via the keypad or other means. An IWF supporting this feature may send a STU-III BDI originated message to an analog user by audio; a STU-III BDI terminal may either generate audio or show the message on the user display. The format of the Predefined Message is shown in Figure 4.3.5.2.1.2-3.

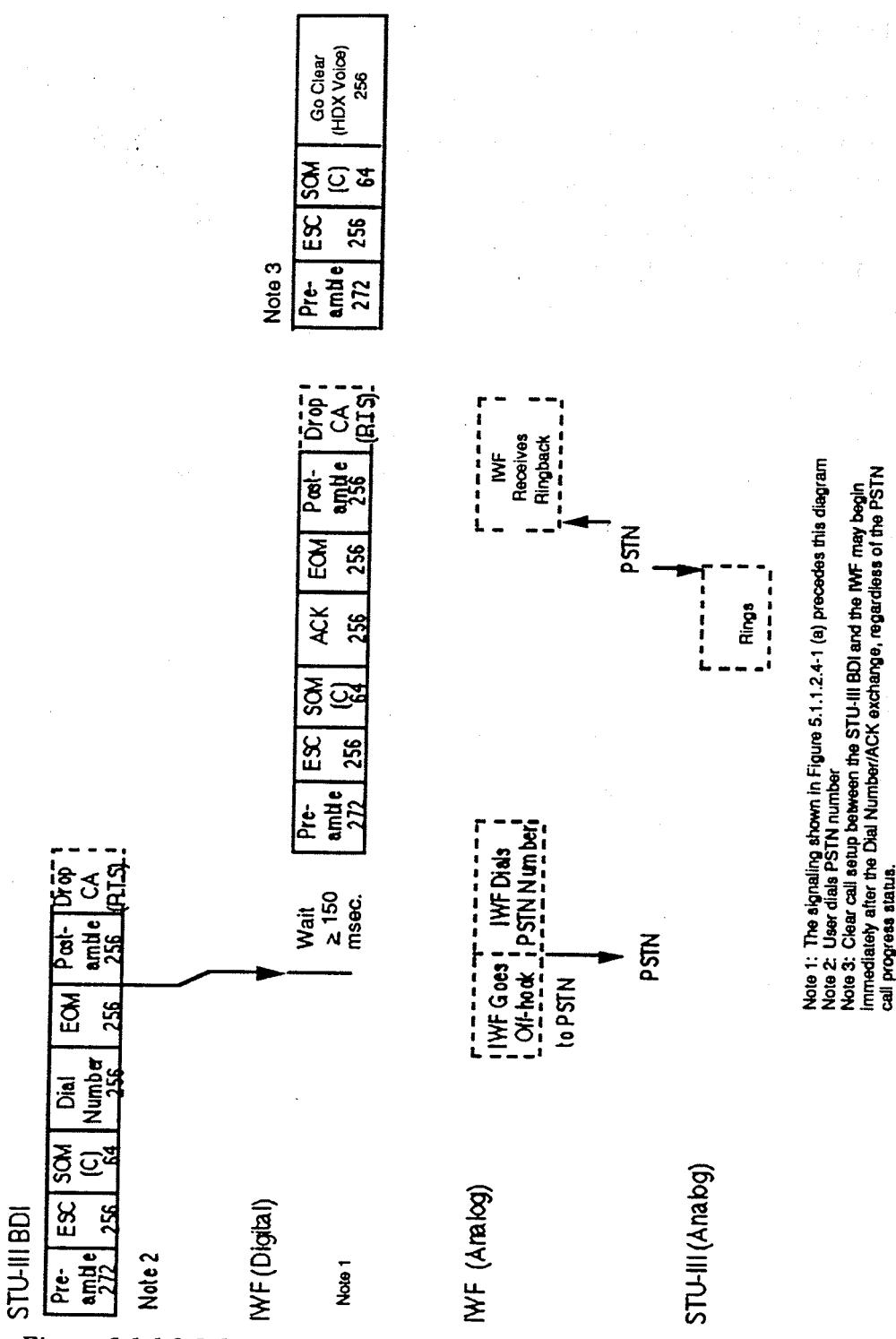


Figure 5.1.1.2.5-1 (a) Half Duplex Clear Mode Signaling for a STU-III BDI Calling an Analog STU-III

MID	Data Field	Parity
16 bits	14 bytes	16 bytes (128 bits)

MID - 20AA hex

Data Field - contains ASCII text message content, (specifics TBD)

Parity - for the BCH block encoding

Figure 4.3.5.2.1.2-3 Predefined Message Format

Exception Message (MER and OC)

The Exception Message provides a mechanism for the IWF to provide feedback to a STU-III BDI user when the IWF encounters a "telco side" problem. In addition, it may be used to relay a problem from one STU-III BDI to another STU-III BDI or IWF. It shall be an Optional Capability (OC), indicated in the Y and Z Messages exchanged during alerting.

Currently, four different error messages are defined in Table 4.3.5.2.1.2-2. The first two bytes of the data field for the Exception Message shall contain an ASCII codeword for the various error messages. The remaining 12 byte field shall contain the ASCII message followed by spaces. Table 4.3.5.2.1.2-2 provides these codewords for the four defined errors. Additional error codes may be added as necessary.

ASCII Message (in quotes)	Codeword (ASCII)
AUTOVON "Preempt" Detected	01
"No CIK"	03
"PSTN On-Hook"	05
"PSTN Fade" Detected	06

Table 4.3.5.2.1.2-2 Exception Message Codewords

The format for the Exception Message is shown in Figure 4.3.5.2.1.2-4.

5.1.1.2.5 Half-Duplex Clear Mode Signaling (MER - OC)

The IWF shall support all signaling specified in Section 4.3.5.3.2 for the STU-III BDI half-duplex clear mode of operation. Figure 5.1.1.2.5-1 illustrates the half-duplex clear mode signaling for the scenario in which the STU-III BDI terminal is calling an analog STU-III terminal through an IWF. This timeline assumes two-stage dialing is needed. Therefore, the use of the Dial Number message is required. The IWF and STU-III BDI terminal shall exchange standard alerting signaling as specified in Section 4.3.5.3.2, with the STU-III BDI assuming the role of the HDX Clear Responder; and the IWF assuming the role for the HDX Clear Initiator. This shall occur transparent to the analog STU-III. When the IWF receives the Dial Number Message, it shall dial the analog STU-III number on the PSTN. Note the IWF shall ignore clear voice traffic from the analog STU-III, and shall not transmit clear voice traffic to the analog STU-III until the IWF and the STU-III BDI have completed the exchange of alerting signaling and clear mode control signaling.

Figure 5.1.1.2.5-2 illustrates the half-duplex clear mode signaling for the scenario which an analog STU-III is calling the STU-III BDI terminal through an IWF. The analog STU-III and IWF shall exchange standard signaling and supervision over the PSTN; this shall occur transparent to the STU-III BDI terminal. When the IWF receives DTMF tones from the analog STU-III, it shall begin clear alerting signaling with the STU-III BDI terminal, as specified in Section 4.3.5.3.2. Note that the IWF shall ignore clear voice traffic from the analog STU-III and shall not transmit clear voice traffic to the analog STU-III until the IWF and the STU-III BDI have completed the exchange of alerting signaling and clear mode signaling.

MID 16 bits	Exception Code 2 bytes	Data Field 12 bytes	Parity 16 bytes (128 bits)
----------------	---------------------------	------------------------	-------------------------------

MID - 2077 hex

Exception Code - contains 2 byte code from Table 4.3.5.2.1.2-2

Data Field - contains ASCII message corresponding to Exception Code in Table 4.3.5.2.1.2-2, remaining bytes are set to "", space, 12 bytes total

Parity - for the BCH block encoding

Figure 4.3.5.2.1.2-4 Exception Message Format

Several examples of the use of these messages are shown in the signaling diagrams in Section 5.1.1.2.4.

Secure Capabilities Message (OC)

The Secure Capabilities Message shall be used to pass secure mode capabilities information from a STU-III BDI terminal to an IWF. This allows a STU-III BDI user to change the pre-staged secure capabilities information previously sent to the IWF during the Y/Z message exchange of initial clear call establishment. This message shall be sent to an IWF when a STU-III BDI user reconfigures the secure configuration of the STU-III BDI during clear mode operation. This will enable the IWF to update its pre-staged secure information in preparation for secure call setup. (For more details refer to Section 4.3.6.1.1.) The Secure Capabilities Message shall be an Optional Capability, (OC), indicated in the Y and Z Messages exchanged during alerting.

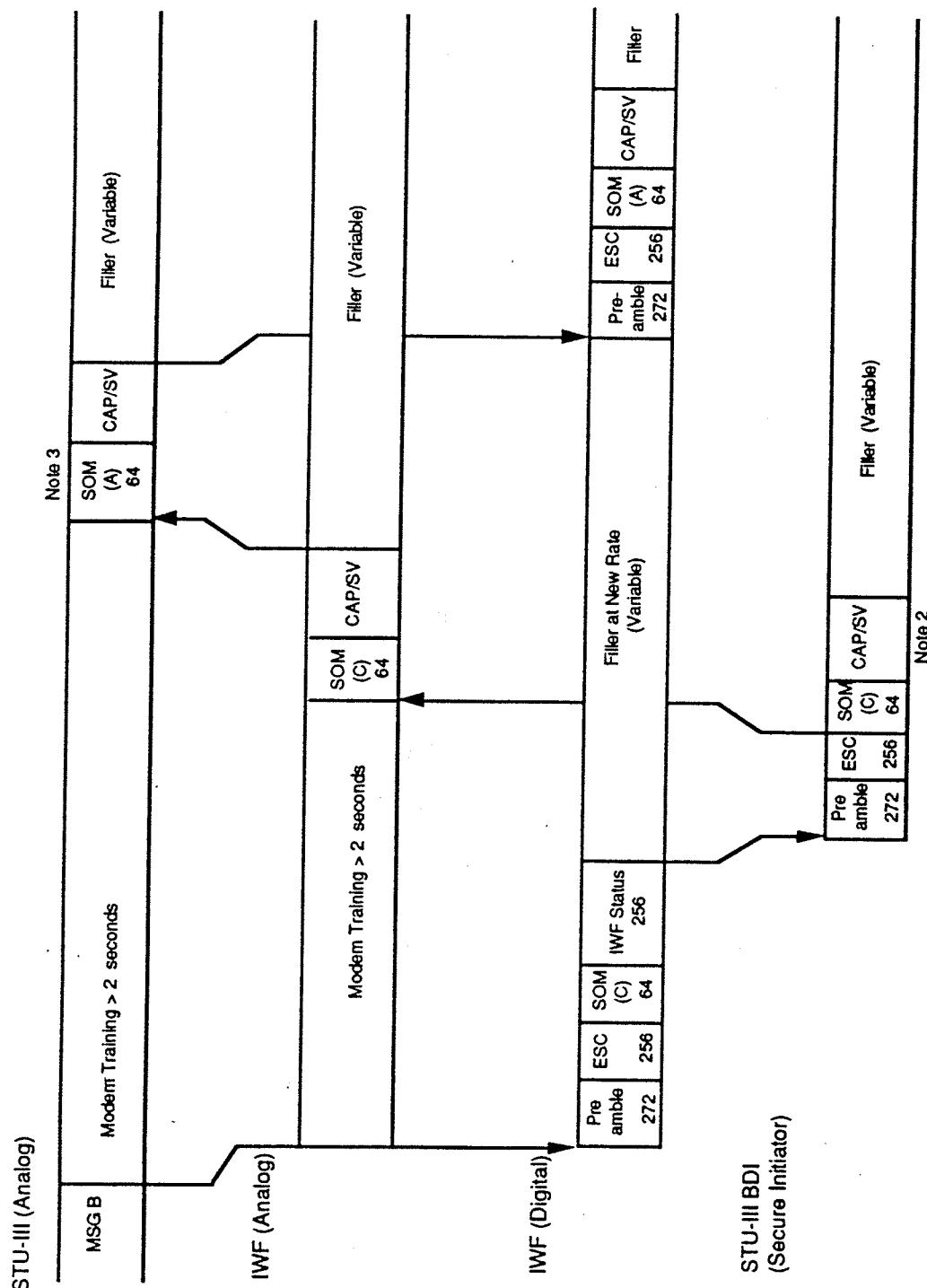


Figure 5.1.1.2.4-4 (b) Full-Duplex Clear Mode Auto-Secure on Answer Signaling for an Analog STU-III Calling a STU-III BDI

MID 16 bits	Secure Capabilities Codeword 1 bytes	Unused Data Field 13 bytes	Parity 16 bytes (128 bits)
----------------	--	-------------------------------	-------------------------------

MID - 2088 hex

Secure Capabilities Codeword - contains 1 byte code from Table 4.3.6.1.1.1-2

Unused Data Field - contains all zeros

Parity - for the BCH block encoding

Figure 4.3.5.2.1.2-5 Secure Capabilities Message Format

4.3.5.2.1.3 Clear Mode Control Messages (MER - OC)

Two messages are defined for controlling the STU-III BDI clear mode selection process. They are referred to herein as Clear Mode Control messages, and are shown in Table 4.3.5.2.1.3-1. Clear Mode Control messages shall contain a two byte MID followed by a 14 byte data field. Clear Mode Control messages shall always be transmitted in complete BCH blocks and scrambled using the GPC Message Scrambling Pattern when transmitted by either the Clear Initiator or Clear Responder terminal. All Clear Mode Control messages shall be preceded by the Initiator SOM, SOM(C), (as defined in FSVS-210), even if transmitted by the Clear Responder.

Each transmitted Go Clear message must be acknowledged by the receiving end with a Clear ACK message. If the transmitter of a Go Clear message fails to receive an acknowledgment within a timeout period of 3.3 ± 0.7 seconds (optionally, for an extended mode timeout an additional 6 seconds may be used), it shall retransmit the Go Clear message. After three unacknowledged retransmission attempts, (for a total of four) the transmitter shall revert to alerting mode and transmit the On-Hook alert and notify its user.

Message	MID (Hex)
Go Clear	1330
Clear ACK	1220

Table 4.3.5.2.1.3-1 Clear Mode Control Messages

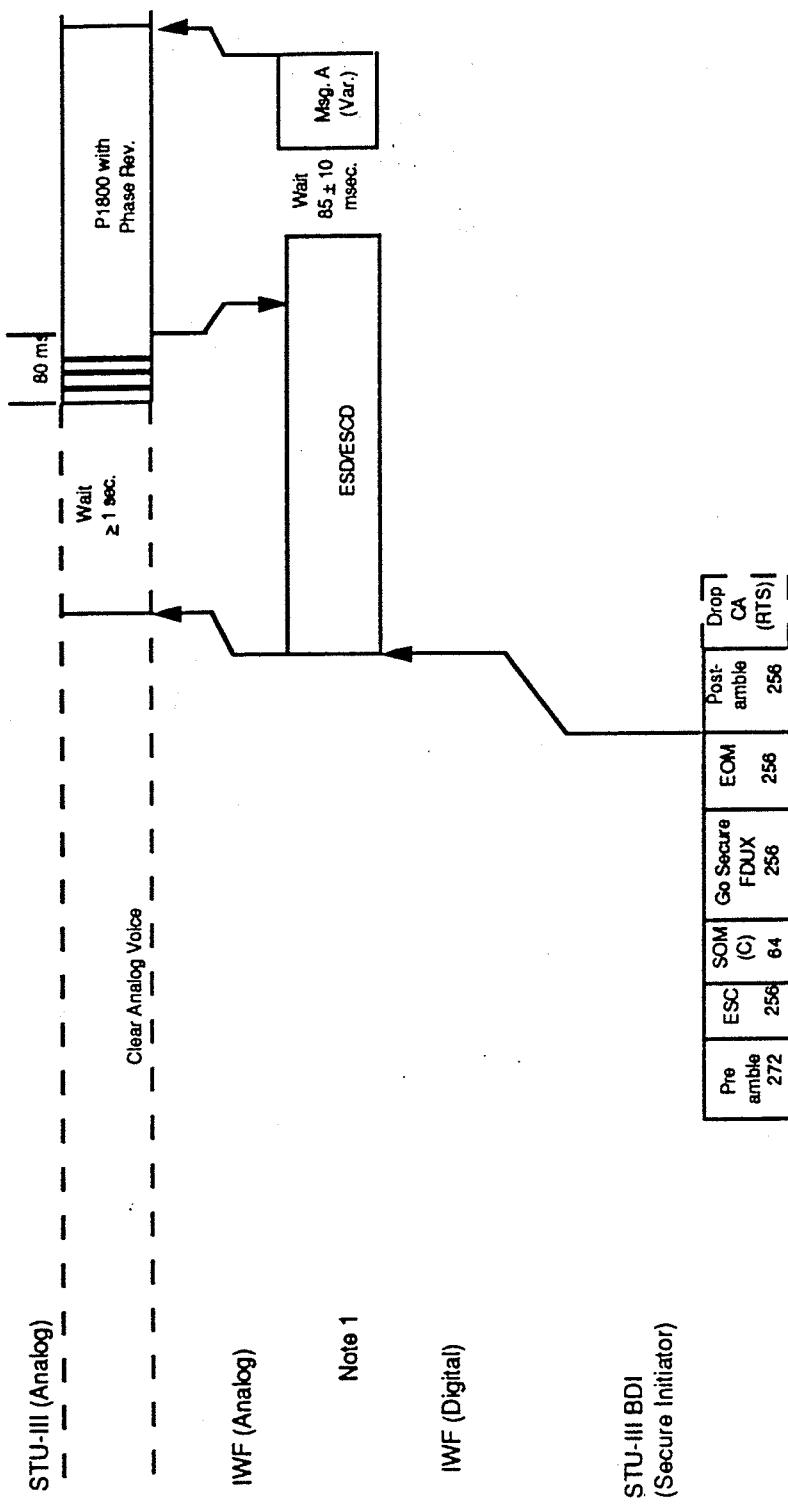


Figure 5.1.1.2.4-4 (a) Full-Duplex Clear Mode Auto-Secure on Answer Signaling for an Analog STU-III Calling a STU-III BDI

The Clear Mode Control messages shall contain a two byte codeword specifying the clear mode service selection. The codeword shall be transmitted in the first two bytes of the 14-byte data field of all Clear Mode Control messages. The clear mode services and their corresponding codewords are listed in Table 4.3.5.2.1.3-2.

The remaining 12 bytes of the data field in the Clear Mode Control messages are normally reserved and shall contain all hex zeros. However, if modem training fails on the analog side between an IWF and an analog STU-III, the IWF shall send a Go Clear message to the BDI with an ASCII character "F" in the first byte of the unused data field to specify the failure and revert to a clear mode. Also, the Clear Mode Control messages may, as an optional capability, contain an ASCII source address in the last seven bytes of the data field. The Clear Mode Control message format is shown in Figure 4.3.5.2.1.3-1.

MID	Codeword	Data Field - 12 bytes			Parity
		fail flag	unused	source address	
16 bits	16 bits	1 byte	4 bytes	7 bytes	16 bytes (128 bits)

MID - from Table 4.3.5.2.1.3-1

Codeword - contains the codeword corresponding to the selected clear mode as defined in Table 4.3.5.2.1.3-2

Data Field - normally reserved and set to all hex zeros. First byte may also contain ASCII "F" to indicate IWF modem training failure. Last seven bytes may optionally contain ASCII source address.

Parity - for the BCH block encoding

Figure 4.3.5.2.1.3-1 Clear Mode Control Message Format

If a clear vocoder is available, the Go Clear message shall be transmitted when the alerting handshaking has completed. The initial clear voice mode shall be selected from the modes offered in the Y and Z messages. Even if both terminals offer clear voice and data modes, the initial operational mode shall be voice, and the Clear Initiator shall send the Go Clear message with a FDX or HDX voice selection. To insure a common clear mode, all STU-III BDI terminals implementing any clear call mode service (i.e. other than idle) shall support the 2400 bps clear voice mode (LPC-10e vocoder) also. Clear data modes may only be initiated after a clear voice mode is established by a mode change from voice to data as specified in Section 4.3.5.3.1.

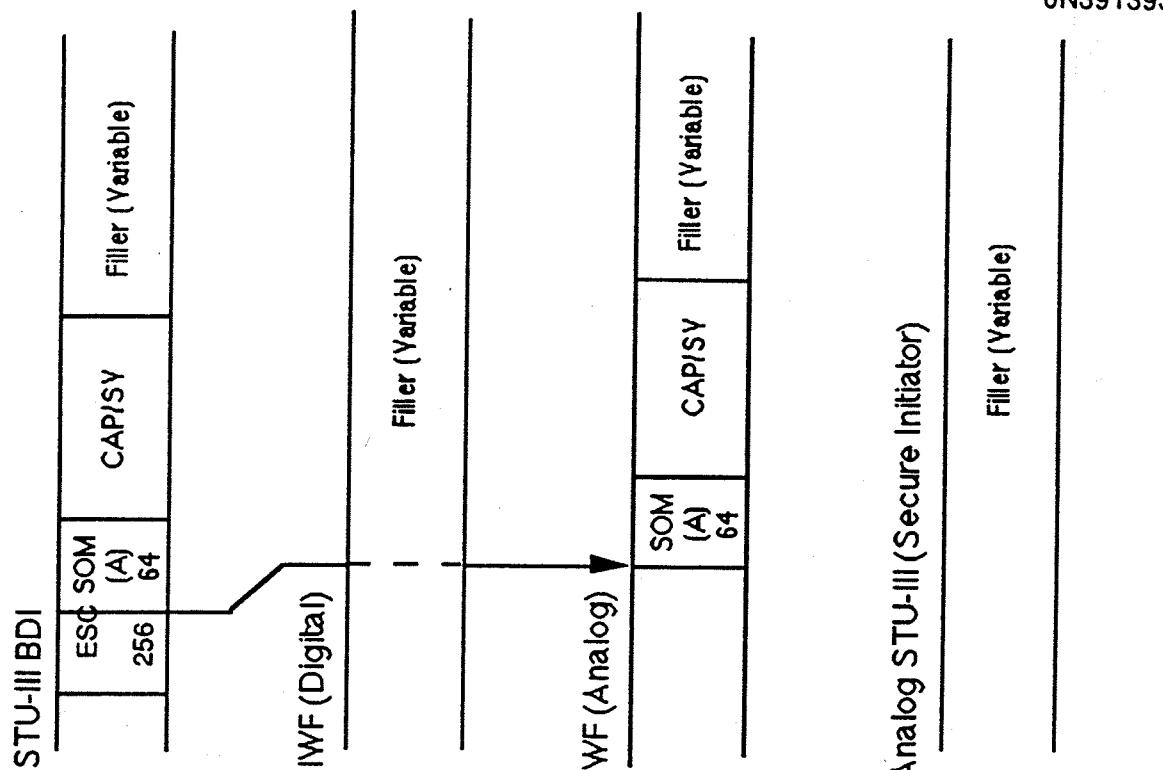


Figure 5.1.1.2.4-3 (c) Full-Duplex Clear Mode Auto-Secure on Answer Signaling for a STU-III BDI Calling an Analog STU-III

Both the mode and traffic rate shall be selected via the codeword set in the Go Clear message. The clear initiating terminal shall select the clear voice mode with the highest precedence supported in both its Z message and the Responder's Y message. (Note: for initial clear call setup, the Clear Initiator is the Call Responder which sent the Z message.) Table 4.3.5.2.1.3-2 defines the order of precedence of the clear voice modes, where a 1 is the highest, and 13 is the lowest (both 12 and 13 are required if any other clear modes are supported). The responding terminal shall confirm the selection by transmitting the same codeword in the Clear ACK message.

If a clear data mode service is desired, either terminal may initiate a data service only after a clear voice mode has been entered. If a user selects a data mode not supported in both the Y and Z messages the terminal shall prompt the user for an alternate selection. A STU-III BDI equipment shall not initiate the signaling of a service selection that is not supported in both the Y and Z messages.

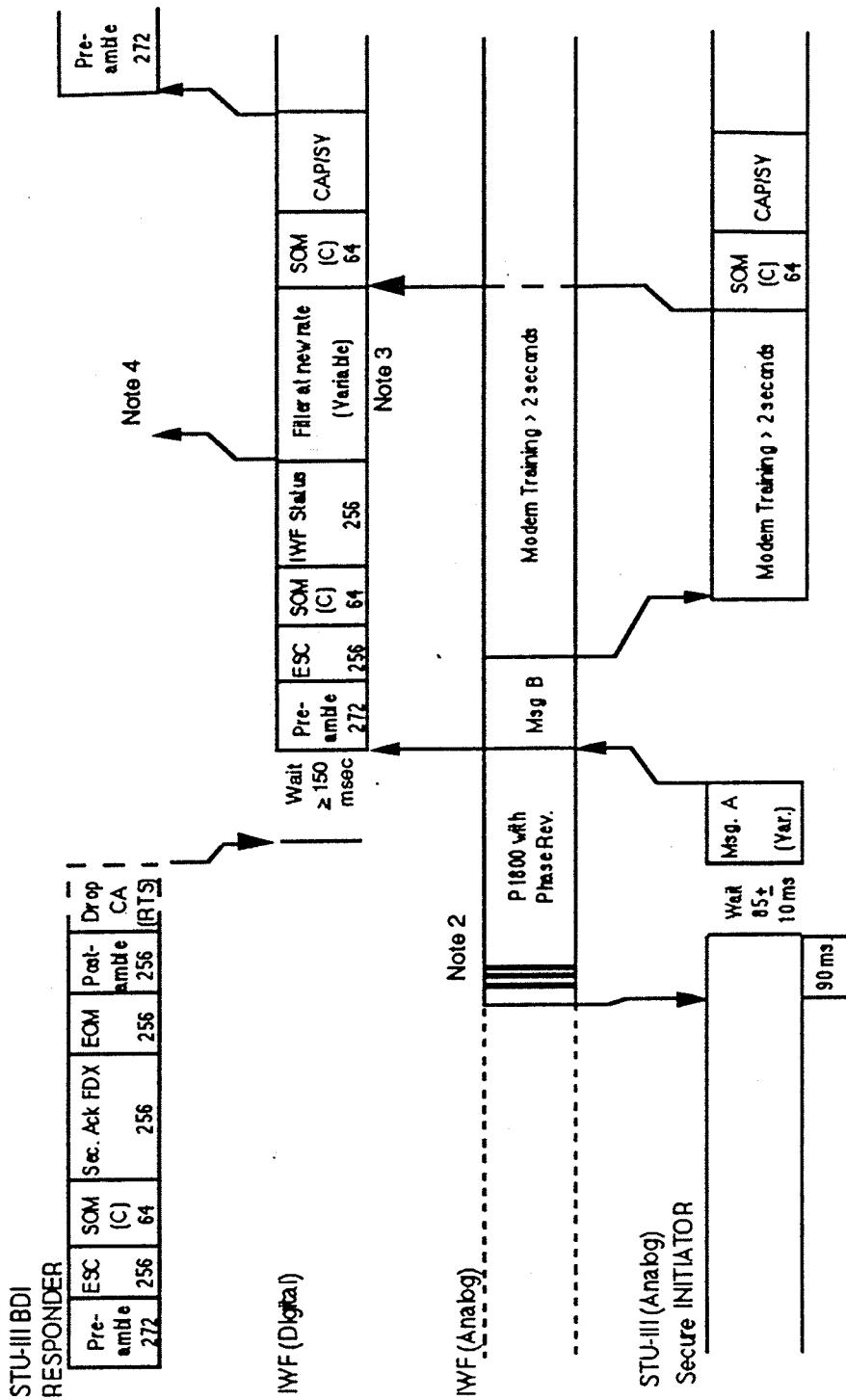
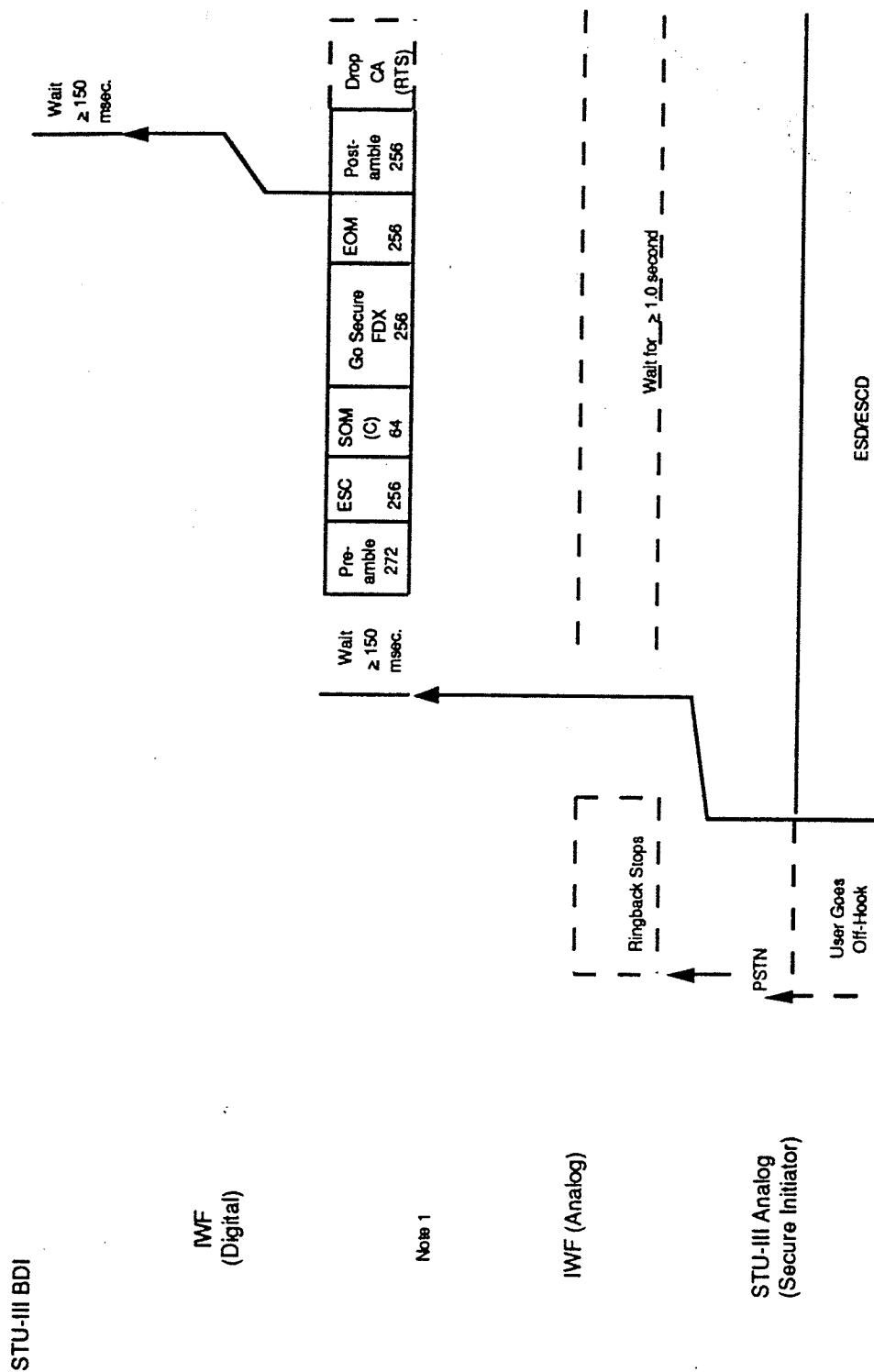


Figure 5.1.1.2.4-3 (b) Full-Duplex Clear Mode Auto-Secure on Answer Signaling for a STU-III BDI Calling an Analog STU-III

Clear Mode	Codeword (Hex)	Precedence
FDX 9600 bps MRELP vocoder	7796	1
FDX 4800 bps RCELP vocoder	7749	2
FDX 4800 bps CELP vocoder	7748	3
FDX 32000 bps CVSD vocoder	7732	4
FDX 16000 bps CVSD vocoder	7716	5
FDX 2400 bps LPC-10e vocoder	7724	6
FDX External DNVT Mode	7700	NA
HDX 9600 bps MRELP vocoder	3396	7
HDX 4800 bps RCELP vocoder	3349	8
HDX 4800 bps CELP vocoder	3348	9
HDX 32000 bps CVSD vocoder	3332	10
HDX 16000 bps CVSD vocoder	3316	11
HDX 2400 bps LPC-10e vocoder	3324	12
HDX IDLE	3300	13
FDX 32000 bps data	6632	NA
FDX 16000 bps data	6616	NA
FDX 14400 bps data	6614	NA
FDX 9600 bps data	6696	NA
FDX 4800 bps data	6648	NA
FDX 2400 bps data	6624	NA
HDX 32000 bps data	4432	NA
HDX 16000 bps data	4416	NA
HDX 14400 bps data	4414	NA
HDX 9600 bps data	4496	NA
HDX 4800 bps data	4448	NA
HDX 2400 bps data	4424	NA
<i>Table 4.3.5.2.1.3-2 Clear Mode Selection Codewords</i>		



Note 1: The signalling shown in Figure 5.1.1.2.4-1 (a and b) precedes this diagram.

Figure 5.1.1.2.4-3 (a) Full-Duplex Clear Mode Auto-Secure on Answer Signaling for a STU-III BDI Calling an Analog STU-III

If the Responder does not have its DTE ready, then it shall respond with a Clear ACK (FDX or HDX) with the codeword selection corresponding to the previous clear voice state. An example of this clear mode negotiation is shown in the thread diagram in Table 4.3.5.2.1.3-3. Transmission of the Clear ACK (FDX or HDX), by the Clear Responder shall indicate acceptance or rejection of the requested clear voice (data) mode.

The Clear Responder shall not follow a Clear ACK (FDX or HDX) message transmission with clear vocoder (data) frames. Rather, the Clear Initiator shall always start sending clear traffic frames first (at the new rate or rate adapted if necessary) and the Clear Responder shall follow. The start of traffic may be delayed if the Initiator thought it would be changing rates. Note, all full-duplex Clear Mode Control messages shall be sent in full-duplex mode followed by filler. Clear Mode Control signaling is specified in Section 4.3.5.3.

STU-III BDI #1	BDN	STU-III BDI #2
Go Off-Hook	----- Ring/Y 2,1 -----> <----- Ring ACK/Z 1,2 -----> <----- Off-Hook/Z 1,2 -----> ----- ACK 2,1 -----> <----- Go Clear (7748) -----> ----- Clear ACK (7748) -----> <----- Clear Voice Traffic ----->	Go Off-Hook
Presses Clear Data.	----- EOM -----> <----- EOM -----> ----- Go Clear (6696) -----> <----- Clear ACK (7748) -----> <----- Clear Voice Traffic ----->	DTE not ready.

Table 4.3.5.2.1.3-3 Clear Mode Negotiation Thread

Figures 5.1.1.2.4-3 and 5.1.1.2.4-4 illustrate the full duplex clear mode interruption signaling for the scenario in which one of the terminals is strapped for Auto-Secure on answer. Figure 5.1.1.2.4-3 illustrates a BDI caller and an analog STU-III strapped for Auto-Secure. Note that this figure shows the STU-III BDI Secure Responder waiting for the Initiator's CAP/SV before sending its own CAP/SV (as required for 2400 bps operation in FSVS-210). If the STU-III BDI terminal is capable of doing so, it may alternately transmit its CAP/SV after receiving the IWF Status message (and before receiving the Initiator's CAP/SV). Thus, the IWF must be capable of buffering the CAP/SV message until the Initiator's CAP/SV is fully received (for 2400 bps operation) or until modem training has been completed (for all other data rates). Figure 5.1.1.2.4-4 illustrates an analog STU-III calling a STU-III BDI strapped for Auto-Secure.

4.3.5.2.2 Traffic Format (MER - OC)

The clear mode traffic format for full-duplex operation is shown in Figure 4.3.5.2.2-1. Full-duplex traffic transmissions shall end with a clear call interruption (see Section 4.3.5.2.3). Figure 4.3.5.2.2-2 shows the clear mode traffic format for half-duplex operation. Half-duplex traffic shall always end with EOM and Postamble. After any half duplex transmission, the BDI terminal must drop carrier within 50 msec. after the transmission of Postamble.

if a circuit CH rate change:

Filler @ new rate	Preamble 272	ESC 256	START SOM(A) 64	Clear Voice or Data Traffic . . .
-------------------	-----------------	------------	-----------------------	-----------------------------------

or if a signaling rate change via rate adaption using word stuffing or error correction:

Filler	Filler rate adapted to new rate	START SOM(A) 64	Clear Voice or Data Traffic . . .
--------	------------------------------------	-----------------------	-----------------------------------

or if no (signaling or line) rate change:

Filler	START SOM(A) 64	Clear Voice or Data Traffic . . .
--------	-----------------------	-----------------------------------

Figure 4.3.5.2.2-1 Full-Duplex Clear Traffic Format

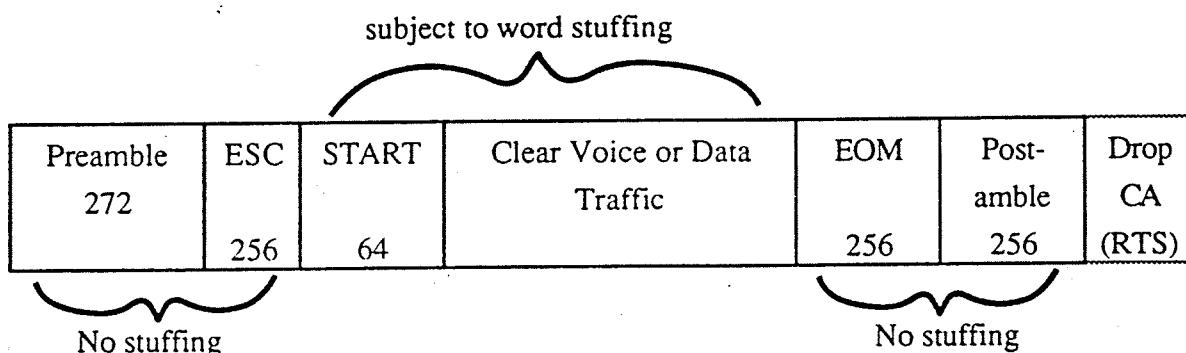
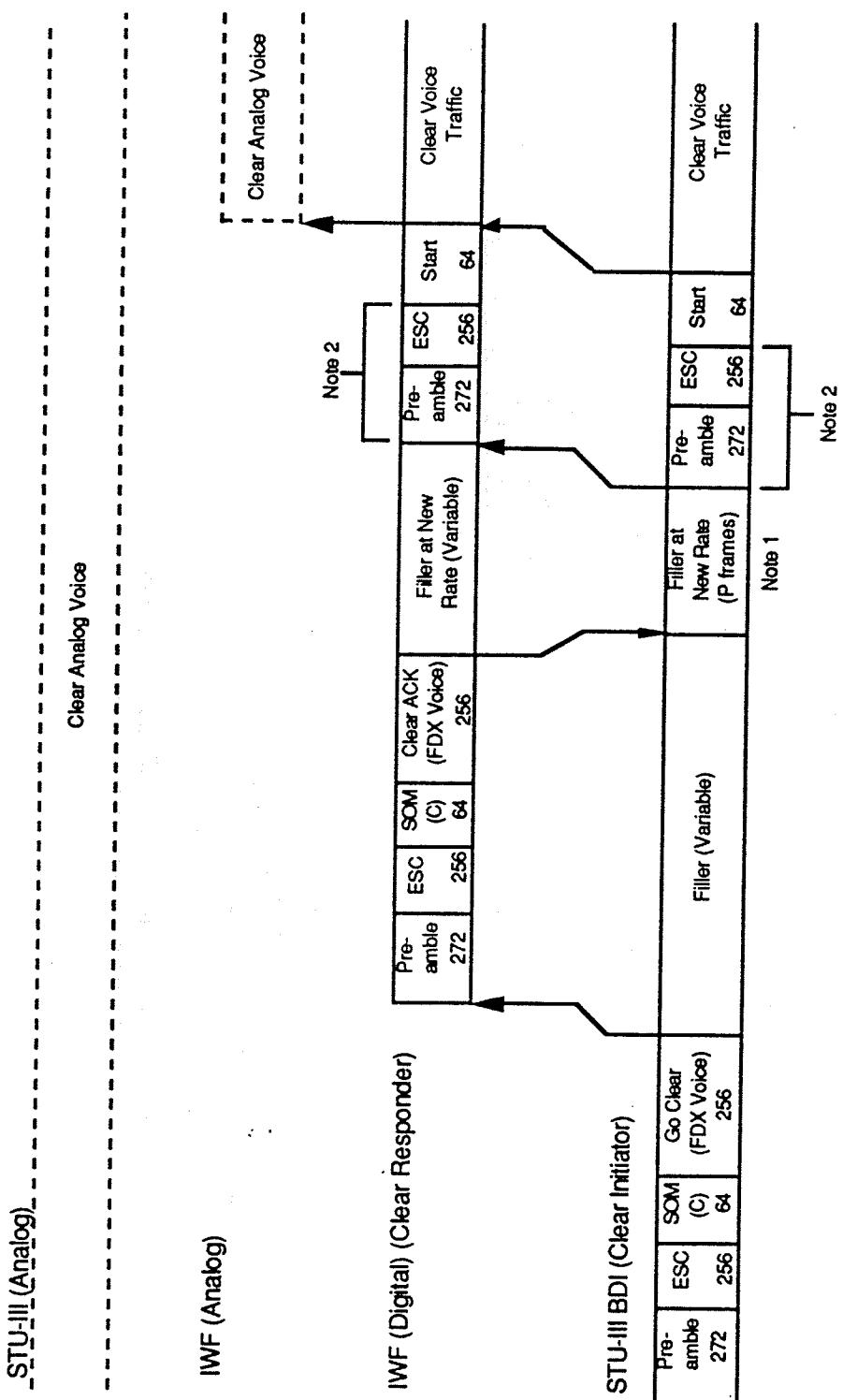


Figure 4.3.5.2.2 Half-Duplex Clear Traffic Format



- Note 1: $P = 4, 9, 19, 24, 28,$ or 56 frames for the new rate of $2400, 4800, 9600, 14400, 16000,$ or 32000 bps respectively.
 Note 2: If no (CH) rate change or word stuffing or error correction is required, i.e., the traffic rate is identical to the current line rate, messages in brackets shall not be transmitted and the previous filler is sent at the current line rate. If a circuit CH rate change is required, these messages shall be transmitted at the new line rate and the previous filler sent at the new rate. If a signalling rate change is required and circuit CH is not supported, these messages are not sent and the previous filler shall be transmitted word stuffed or error corrected. The clear initiator transmits START followed by nonsecure traffic at the current signalling traffic rate. The clear responder shall transmit filler until detection of START and then transmit START followed by nonsecure traffic.

Figure 5.1.1.2.4-2 (d) Full-Duplex Clear Mode Signaling for an Analog STU-III Calling a STU-III BDI (Cont.)

The preamble shall be as defined for alerting messages. The START (Responder SOM, SOM(A) for both full and half duplex clear traffic), ESC, and EOM shall be as defined in FSVS-210 (Reference 1). Postamble shall be as defined for alerting messages. Clear traffic (voice or data) shall be invoked by the Clear Mode Control messages. Clear traffic shall always begin with filler, and/or Preamble and ESC, START (Responder SOM, SOM(A)), and vocoder frames or clear data traffic. Clear traffic, both voice and data, shall be scrambled with the GPC Scrambling Pattern, as defined in FSVS-210.

4.3.5.2.3 Clear Call Interruptions (MER - OC)

The Clear Call Interruption messages shown in Table 4.3.5.2.3-1 shall be transmitted when the normal processing of a clear call is interrupted. Additionally, the Miscellaneous Control messages may also be used to interrupt clear call processing under certain conditions (see Section 4.3.5.2.1.2). The STU-III BDI includes these scenarios/messages in a format similar to that specified in Reference 1.

Condition	Message
ESC to clear voice or data	Go Clear
Go on-hook, hang up	Go On-Hook
Failed Call, line dies and STU-III BDI times out	Go On-Hook
Go Secure	Go Secure FDX (HDX)
Go Secure on Answer	Go Secure FDX (HDX)

Table 4.3.5.2.3-1 Clear Call Interruptions

Clear-mode call interruption messages are transmitted as individual half-duplex messages. When interruptions occur, the "Leader" terminal (terminal initiating the interruption) shall transmit an EOM followed by Postamble and then release the line. The receiving terminal, upon detection of the Leader's EOM, shall disable its handset and terminate its transmission with an EOM/Postamble, and then release the line, becoming the Follower. The Leader terminal shall then transmit Preamble/ESC, SOM(C), the appropriate interruption message (e.g., Go On-Hook, Go Clear, etc.), EOM/Postamble, and then release the line. The Follower shall send the ACK message in response to reception of the interruption message.

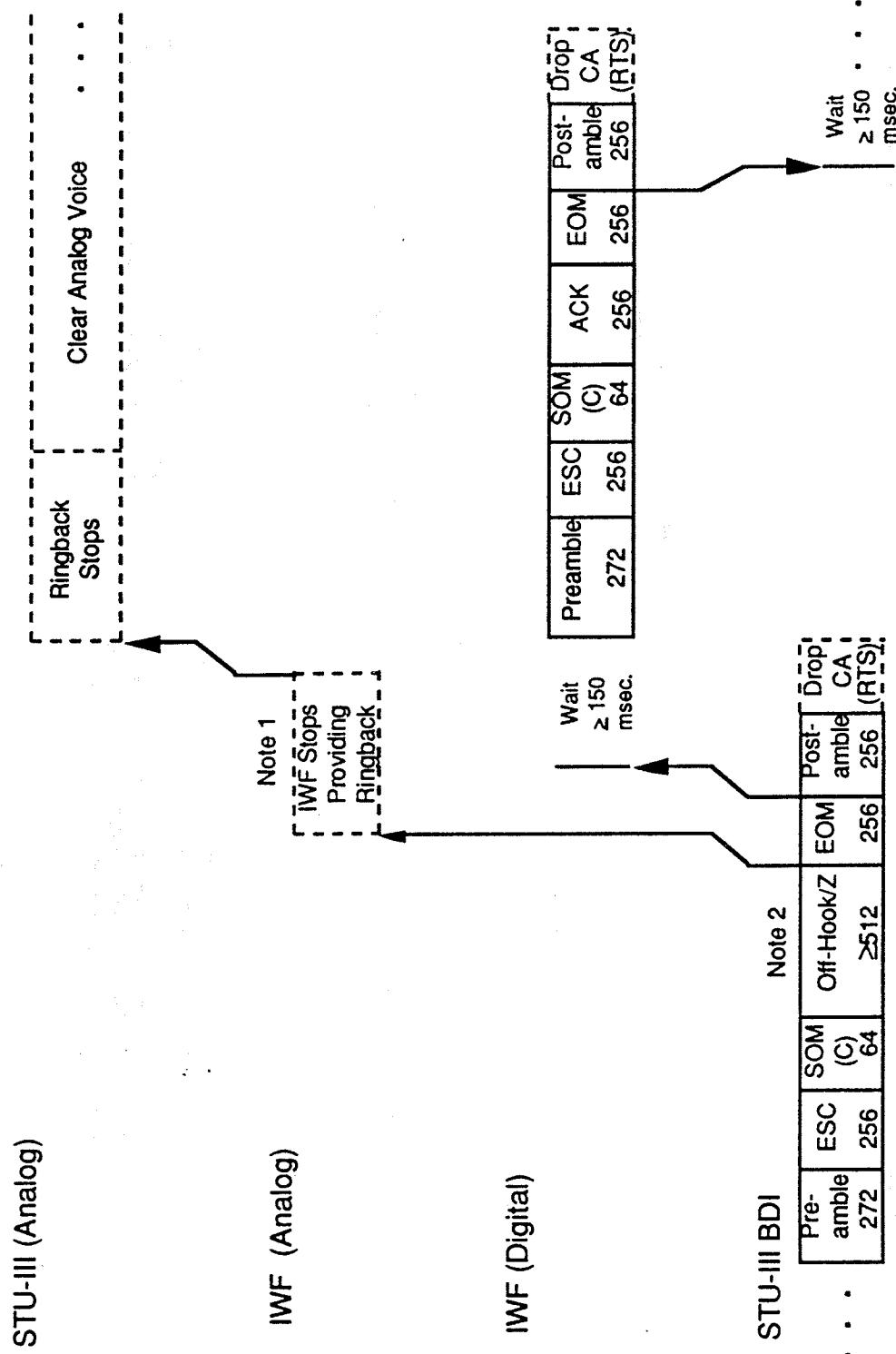


Figure 5.1.1.2.4-2 (c) Full-Duplex Clear Mode Signaling for an Analog STU-III Calling a STU-III BDI (Cont.)

The format for clear call interruption message transmissions is shown in Figure 4.3.5.2.3-1 for full and half-duplex. Sections 4.3.5.3.1 and 4.3.5.3.2 contain signaling diagrams for the various clear call interruption scenarios.

end of transmission:

. . . Traffic	EOM 256	Post- amble 256	Drop CA (RTS)	. . .
---------------	------------	-----------------------	---------------------	-------

followed by (if entering half duplex):

Pre- amble 272	ESC 256	SOM (C) 64	MID 16	DATA 112	PARITY 128	EOM 256	Post- amble 256	Drop CA (RTS)
----------------------	------------	------------------	-----------	-------------	---------------	------------	-----------------------	---------------------

or (if entering full duplex):

Pre- amble 272	ESC 256	SOM (C) 64	MID 16	DATA 112	PARITY 128	Filler . . .
----------------------	------------	------------------	-----------	-------------	---------------	--------------

Figure 4.3.5.2.3-1 Clear Call Interruption Signaling Format

If a Go Clear or Clear ACK is missed, the terminal that misses the message will time out and should then stop transmitting with EOM/Postamble. The other side should also stop transmitting with EOM/Postamble. At this point the Go Clear can be resent, beginning with Preamble/ESC.

4.3.5.3 Clear Call Signaling (MER - OC)

Clear call signaling shall always start with alerting messages followed by clear call setup if a clear voice or data mode is supported. All signaling prior to clear call setup shall be half-duplex. Clear call setup occurs only if a clear traffic mode is to be entered. If no clear traffic mode is supported, the call will remain in the clear HDX Idle (i.e., "alerting") state until secure call initiation begins. If no clear mode other than HDX Idle is provided, a Go Clear (HDX Idle)/Clear ACK (HDX Idle) exchange will occur to transition the call to the HDX Idle mode upon completion of Secure Mode Control, Variable Exchange, or Secure Traffic transmissions. Once the terminal or IWF has entered the HDX Idle state, upon completion of any follow-on Miscellaneous Control and/or Alerting message exchanges, the HDX Idle state is reentered

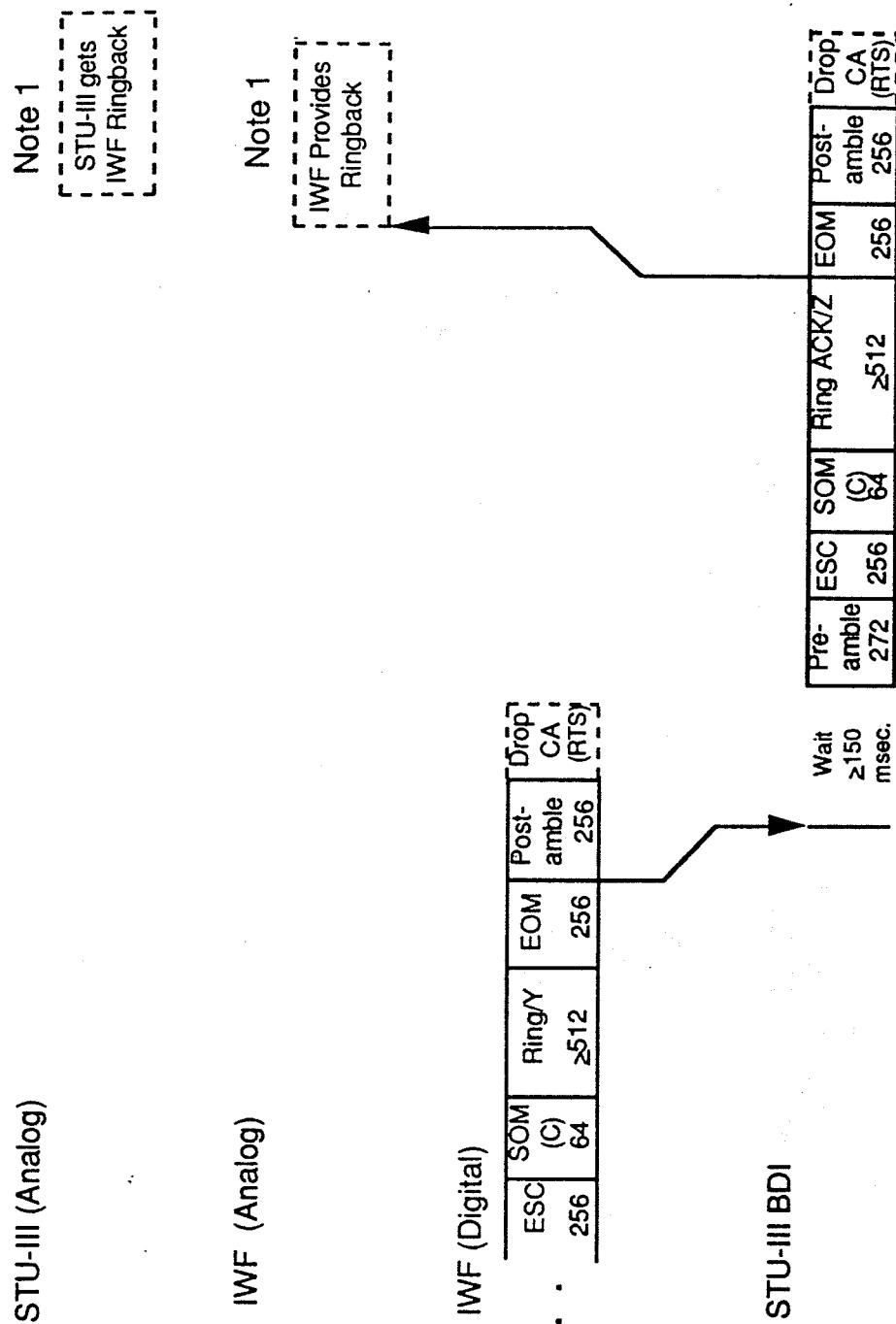


Figure 5.1.1.2.4-2 (b) Full-Duplex Clear Mode Signaling for an Analog STU-III Calling a STU-III BDI (Cont.)

automatically without an exchange of the Go Clear (HDX Idle) and Clear ACK (HDX Idle) messages.

4.3.5.3.1 Full-Duplex Signaling (MER - OC)

The diagrams in this section illustrate the signaling scenarios for full-duplex clear mode operation. Note that the alerting messages are required prior to clear call setup in order to exchange the Y and Z Messages that define the supported capabilities in the clear mode.

The requirements on filler are the same as specified in FSVS-210, page 4-8. That is, filler is always sent as integer multiples of a complete 64-bit message and never truncated. Therefore, the minimum filler shall always be a multiple of 64 bits.

Figure 4.3.5.3.1-1 illustrates the full-duplex clear mode signaling for STU-III BDI to STU-III BDI communications. The selected clear voice mode shall be the highest precedence common vocoder identified in the Y and Z Messages during alerting. Notice that the Clear Initiator shall not start sending filler at the new rate (or with word stuffing or error correction) until it has received the Clear ACK (FDX voice selection) message from the Clear Responder. Also notice that during the alerting (half-duplex) portion of signaling, the half-duplex receiver must wait at least 150 msec. after receiving EOM before it may begin transmitting. This timeout ensures that the transmitting terminal has completed its Postamble transmission and allows a brief amount of idle time between half-duplex turn-arounds.

In the event that a glare condition should occur while attempting to enter the FDX clear mode (i.e., both STU-III BDI terminals transmit Go Clear at approximately the same time) the terminal with the lower digital source address shall become the FDX clear mode Initiator. The other terminal shall then become the FDX clear mode Responder.

Figure 4.3.5.3.1-2 illustrates the full-duplex signaling for STU-III BDI to STU-III BDI communications when the called terminal is strapped for Auto-Secure on Answer. A terminal strapped for Auto-Secure on Answer, shall not initiate a secure call until the alerting scenario has been completed. In this case, the signaling shown in Figure 4.3.5.3.1-1 (a and b) shall precede the Go Secure signaling shown in Figure 4.3.5.3.1-2. Upon reception of the ACK to the Off-Hook/Z message, a called terminal strapped for Auto-Secure on Answer, shall transmit a Go Secure message instead of a Go Clear message after waiting a minimum of 150 msec. after receipt of EOM from the calling terminal. The terminal strapped for Auto-Secure on Answer shall become the Secure Initiator.

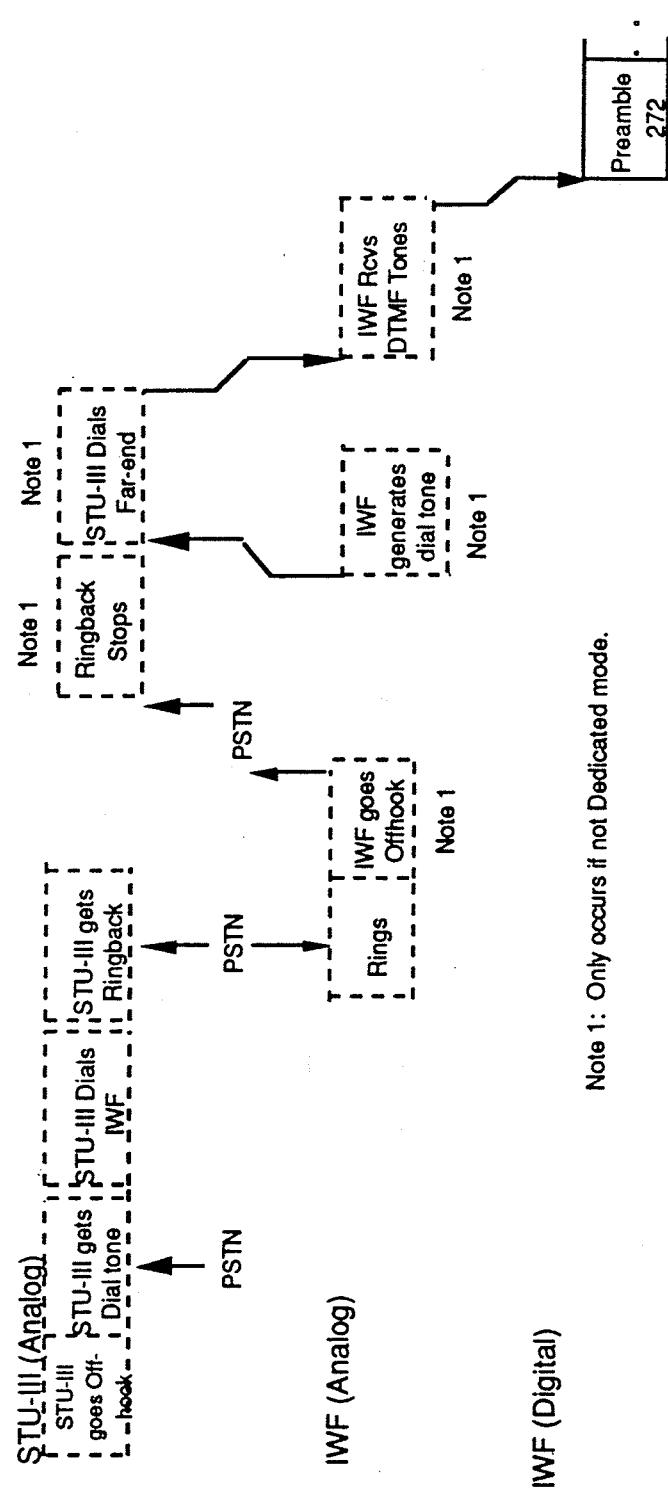


Figure 5.1.1.2.4-2 (a) Full-Duplex Clear Mode Signaling for an Analog STU-III Calling a STU-III BDI

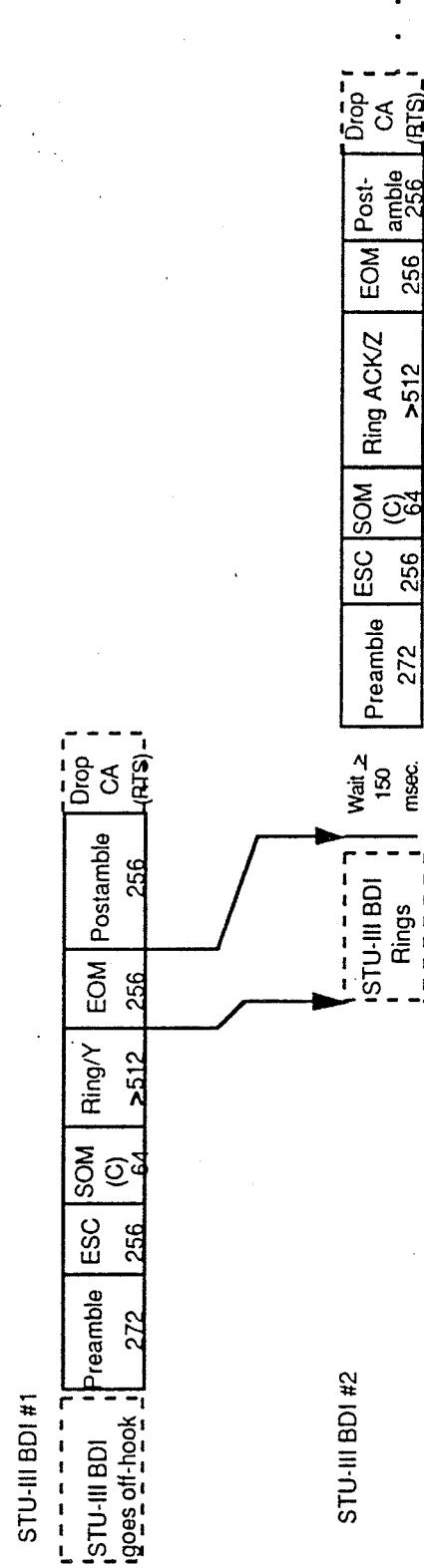


Figure 4.3.5.3.1-I (a) Full-Duplex Clear Mode Signaling for STU-III BDI to STU-III BDI

Figure 5.1.1.2.4-2 illustrates the full-duplex clear mode signaling for the scenario in which an analog STU-III is calling the STU-III BDI terminal through an IWF. The analog STU-III and the IWF shall exchange standard signaling and supervision over the PSTN; this shall occur transparent to the STU-III BDI terminal. (Note: In dedicated mode the IWF will not go off-hook to the PSTN until the STU-III BDI terminal has gone off hook.) When the IWF receives the destination address of the far-end STU-III BDI terminal (built from DTMF tones from the analog STU-III), it shall begin clear alerting signaling with the STU-III BDI terminal, as specified in Section 4.3.5.3.1. Note that the IWF shall ignore clear voice traffic from the analog STU-III, and shall not transmit clear voice traffic to the analog STU-III until the IWF and the STU-III BDI have completed the exchange of alerting signaling and clear mode control signaling.

If the selected clear voice rate is equal to the line rate, i.e., no rate change is required, the IWF shall, upon completing transmission of the Clear ACK (FDX) message, transmit filler until Start is received from the STU-III BDI, and then transmit Start followed by clear voice traffic. The STU-III BDI terminal, upon receipt of the Clear ACK (FDX) message, shall transmit at least P frames of filler (see note 1 in Figure 5.1.1.2.4-2(d)) followed by Start, and clear voice traffic.

If the selected clear voice rate is less than the line rate, and a circuit CH rate change is supported, the IWF shall, upon completing transmission of the Clear ACK (FDX) message, transmit filler at the new BDI line rate. The STU-III BDI, upon receipt of the Clear ACK (FDX) message, shall transmit at least P frames of filler (see note 1 in Figure 5.1.1.2.4-2(d)), followed by Preamble, ESC, Start and clear voice traffic, all at the new BDI line rate. The IWF, upon detection of Preamble from the STU-III BDI, shall transmit Preamble, ESC, Start and clear voice traffic, all at the new BDI line rate.

If the selected clear voice rate is less than the line rate, and a circuit CH rate change is not supported, then only a signaling rate change occurs, requiring rate adaption. The IWF shall, upon completing transmission of the Clear ACK (FDX) message, transmit filler word stuffed or error corrected. The STU-III BDI, upon receipt of the Clear ACK (FDX) message, shall transmit at least P frames of filler (see note 1 in Figure 5.1.1.2.4-2(d)), followed by Start and clear voice traffic, all word stuffed or error corrected. The IWF, upon detection of Start from the STU-III BDI, shall transmit Start and clear voice traffic, all word stuffed or error corrected.

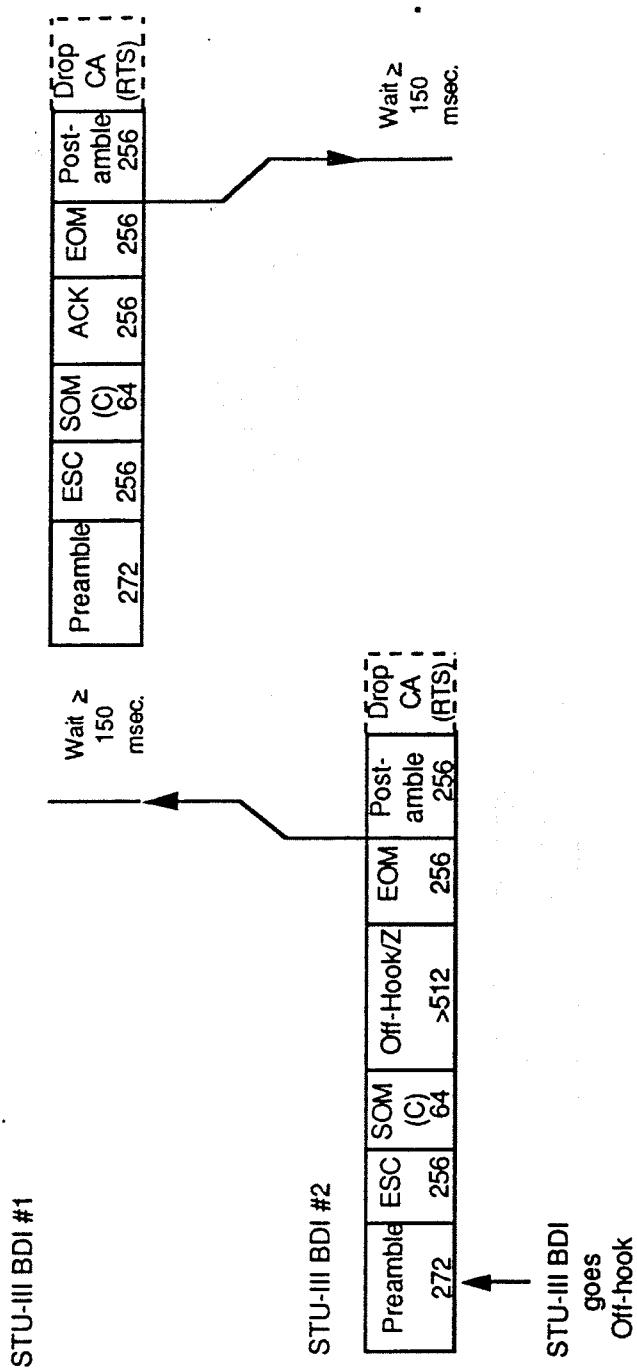


Figure 4.3.5.3.1-I (b) Full-Duplex Clear Mode Signaling for STU-III BDI to STU-III BDI
(Cont.)

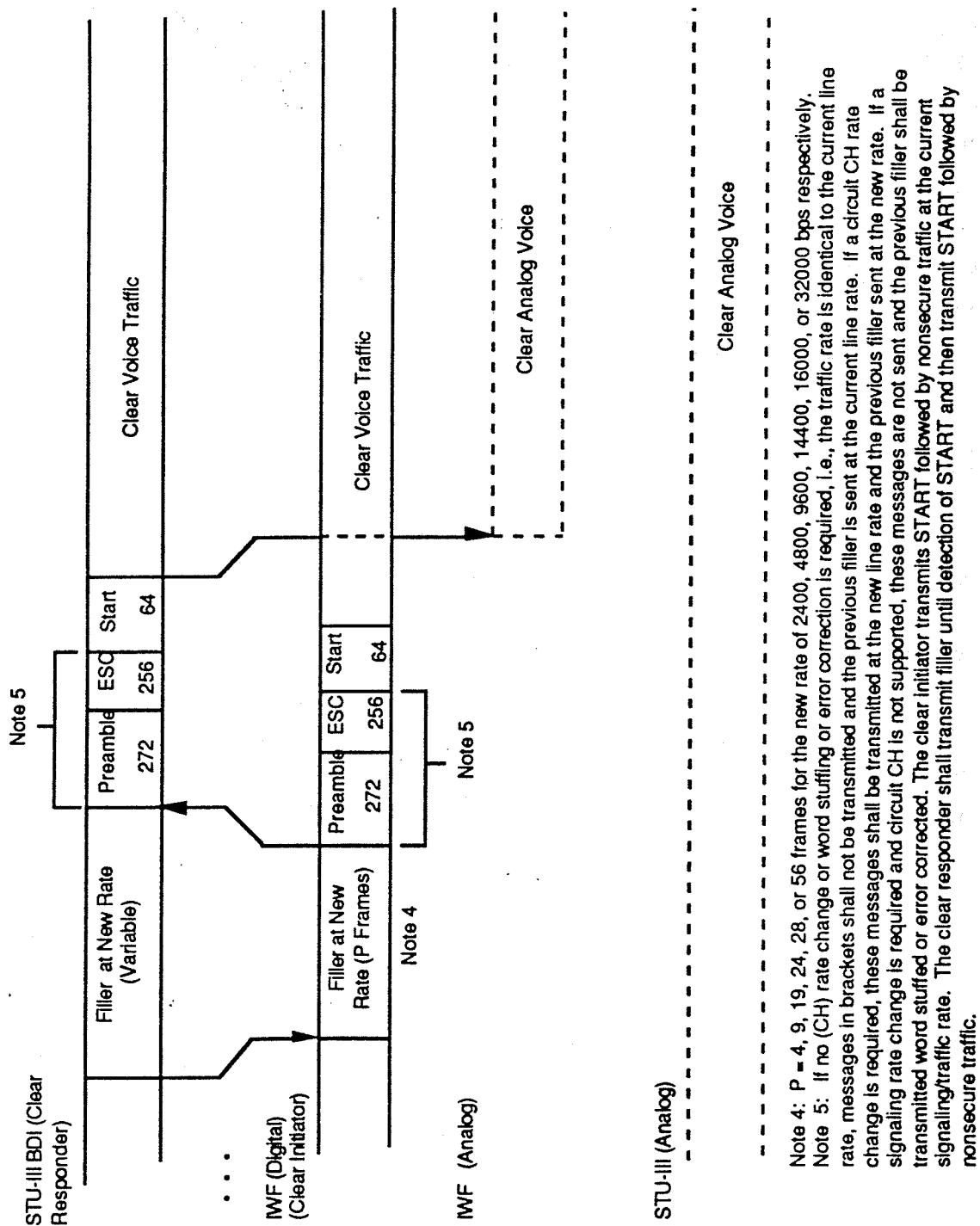
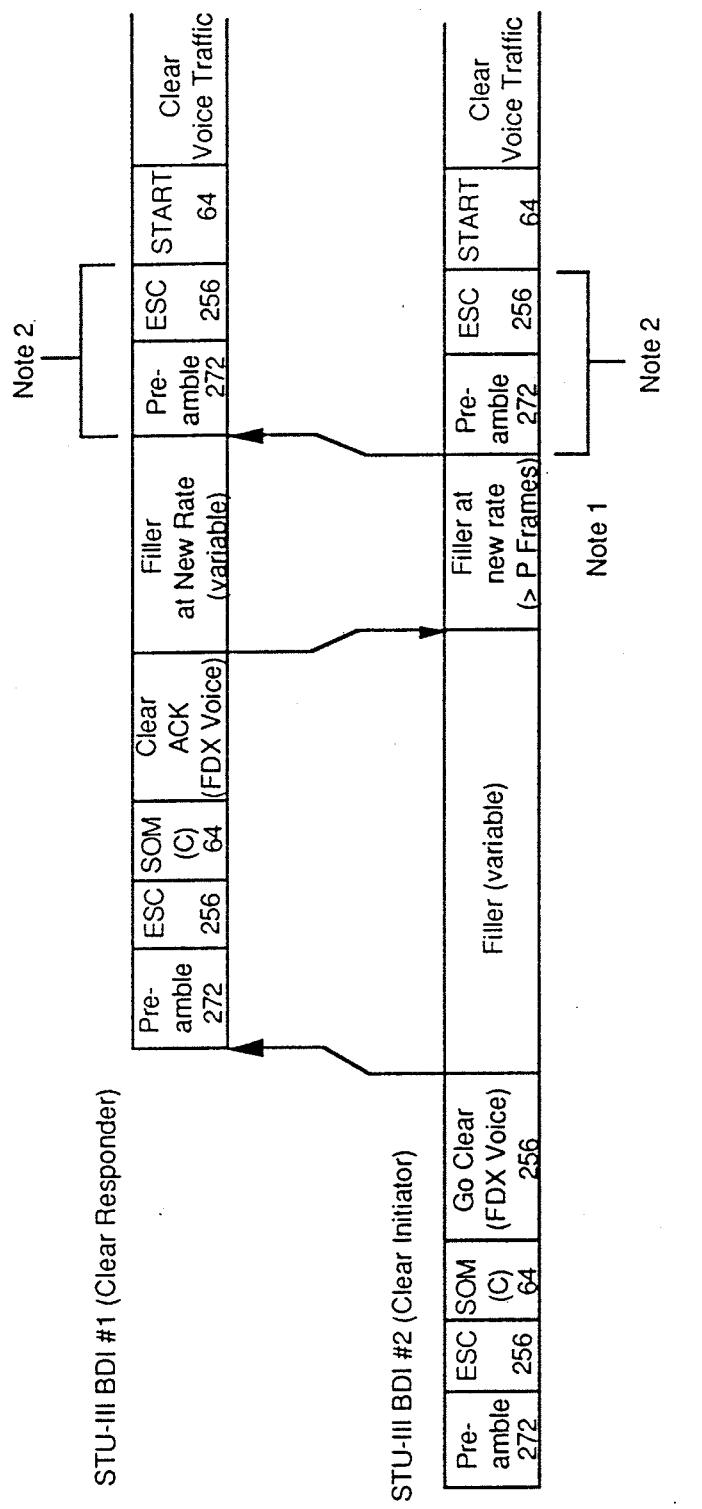


Figure 5.1.12.4-1 (d) Full-Duplex Clear Mode Signaling for a STU-III BDI Calling an Analog STU-III (Cont.)



- Note 1: $P = 4, 9, 19, 24, 28$, or 56 frames (prior to any word stuffing or error correction) for the new rate of 2400, 4800, 9600, 14400, 16000, or 32000 bps respectively.
- Note 2: If no (CH) rate change or word stuffing or error correction is required, i.e., the traffic rate is identical to the current line rate, messages in brackets shall not be transmitted and the previous filler is sent at the current line rate. If a circuit CH rate change is required, these messages shall be transmitted at the new line rate and the previous filler is sent at the new rate. If a signaling rate change is required and circuit CH is not supported, these messages are not sent and the previous filler shall be transmitted word stuffed or error corrected. The clear initiator transmits START followed by nonsecure traffic at the line rate. The clear responder shall transmit filler until detection of START and then transmit START followed by nonsecure traffic.

Figure 4.3.5.3.1-1 (c) Full-Duplex Clear Mode Signaling for STU-III BDI to STU-III BDI
(Cont.)

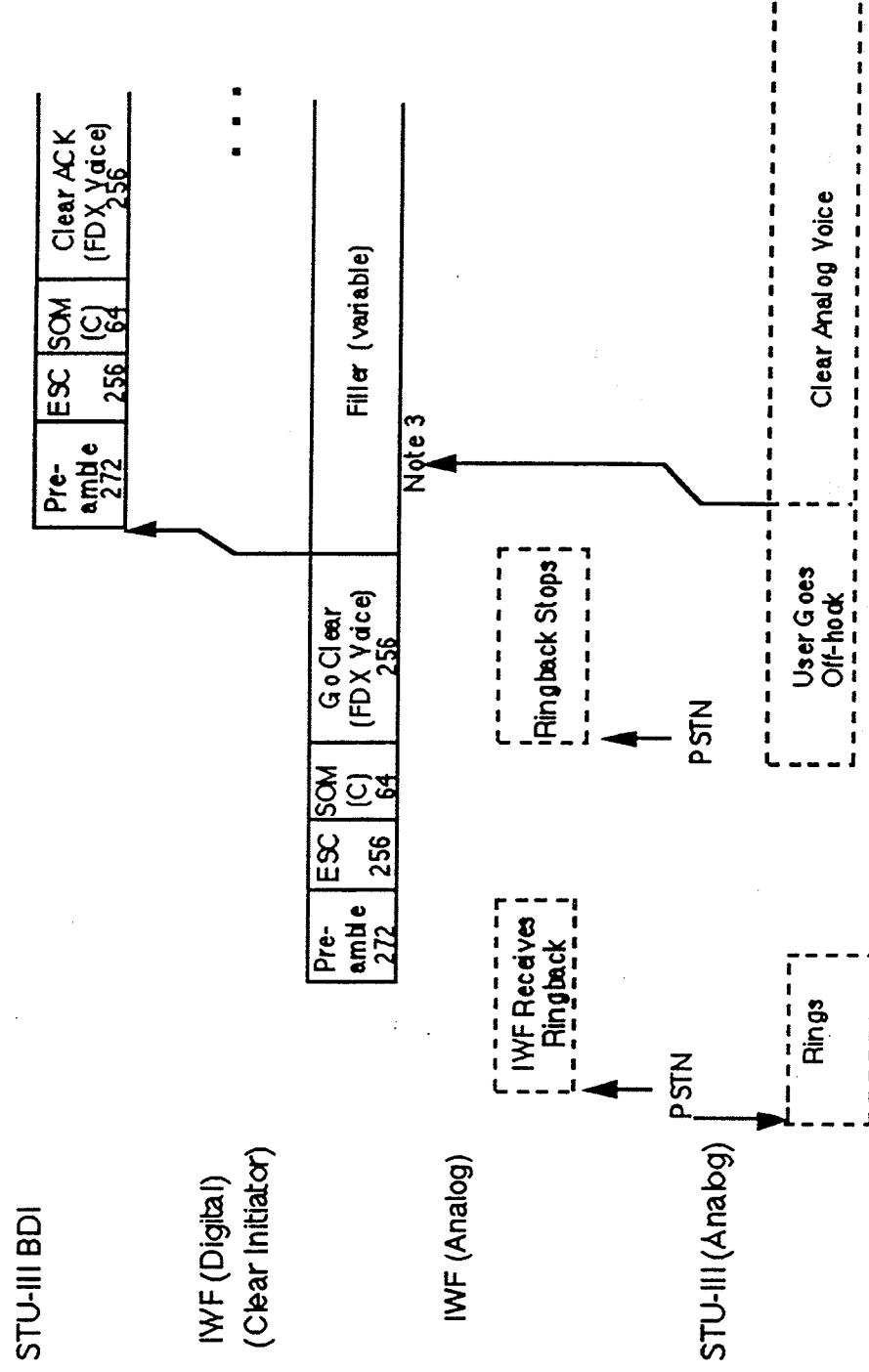
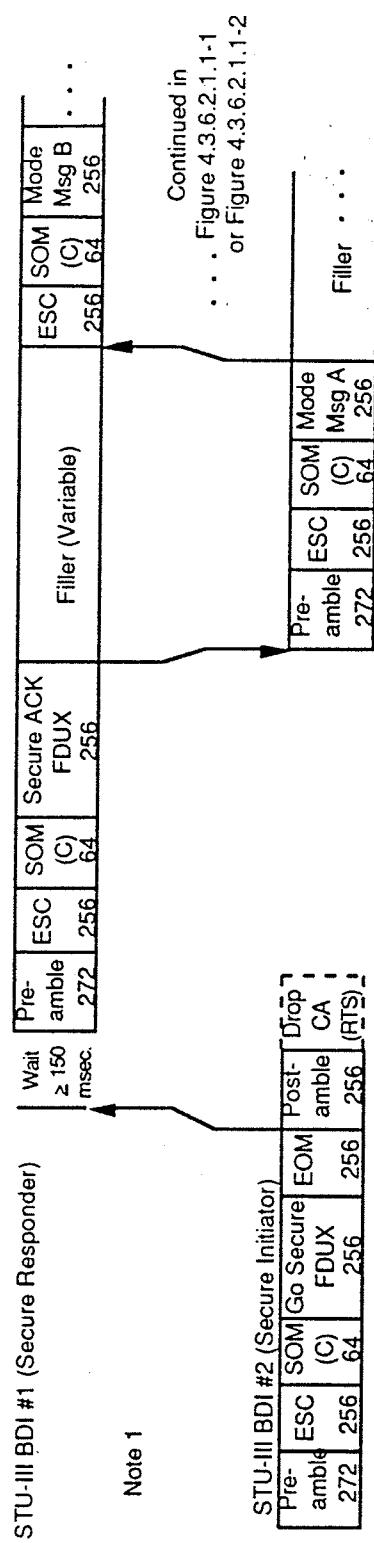


Figure 5.1.1.2.4-1 (c) Full-Duplex Clear Mode Signaling for a STU-III BDI Calling an Analog STU-III (Cont.)



Note 1: The signaling shown in Figure 4.3.5.3.1-1 (a and b) precedes this diagram.

Figure 4.3.5.3.1-2 Full-Duplex Go Secure on Answer with Clear Mode Enabled Signaling for STU-III BDI to STU-III BDI

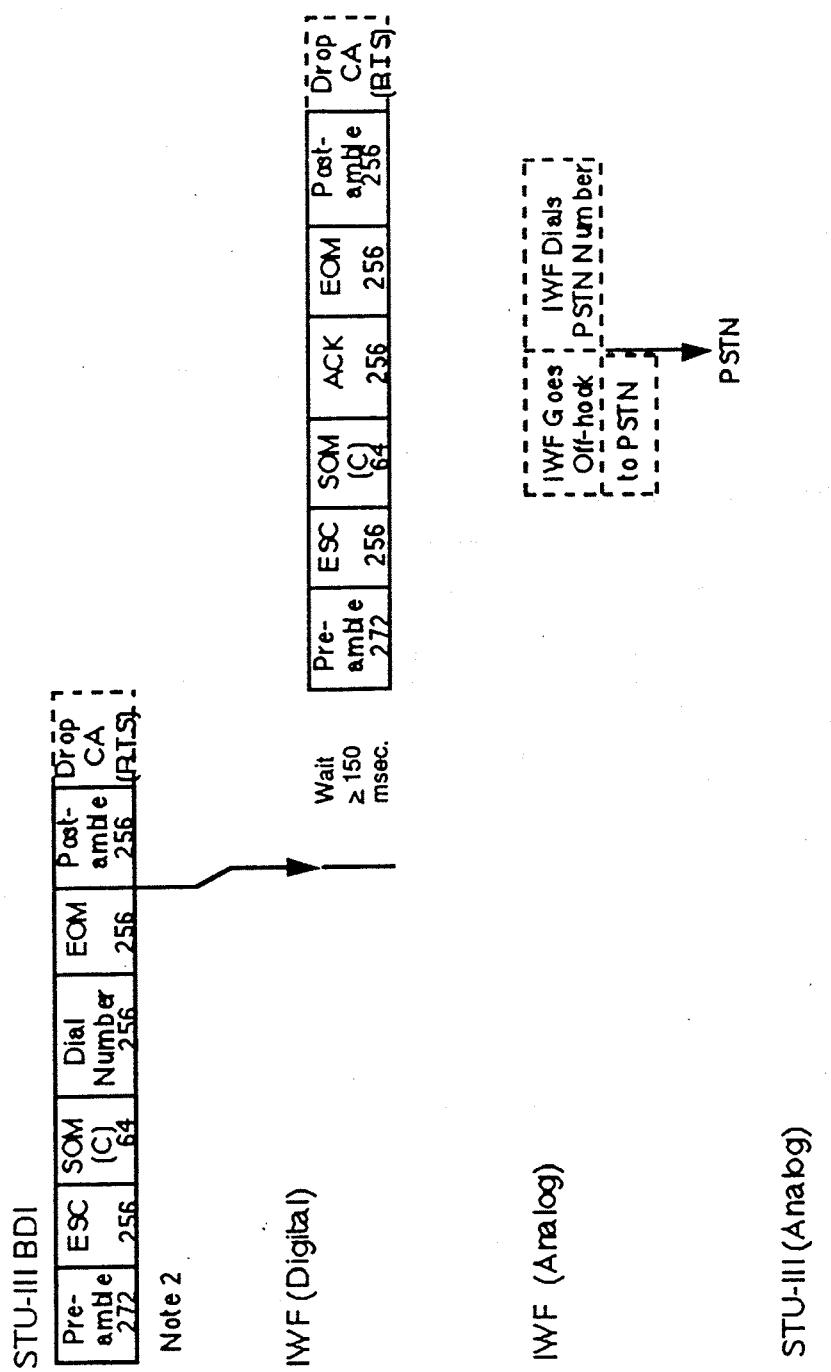


Figure 5.1.12.4-1 (b) Full-Duplex Clear Mode Signaling for a STU-III BDI Calling an Analog STU-III (Cont.)

Figure 4.3.5.3.1-3 illustrates an escape from full-duplex clear voice traffic to a full-duplex clear data mode (or clear data to clear voice) for STU-III BDI to STU-III BDI communications. If a user selects clear data while transmitting clear voice, the STU-III BDI shall disable the handset and transmit EOM and Postamble, becoming the Leader. The receiving STU-III BDI upon detection of EOM, shall disable its handset and transmit EOM and Postamble, becoming the Follower. The clear mode exchange occurs as shown earlier in Figure 4.3.5.3.1-1 for clear call setup.

Figure 4.3.5.3.1-4 illustrates an escape to a secure mode from full-duplex clear mode traffic for STU-III BDI to STU-III BDI communications. If a user selects Secure while transmitting clear traffic, the STU-III BDI shall disable the handset (or data port) and transmit EOM and Postamble, becoming the Secure Initiator. The receiving STU-III BDI upon detection of EOM, shall disable its handset and transmit EOM and Postamble, becoming the Secure Responder. This exchange is followed by secure call setup, shown in Figure 4.3.6.2.1.1-1.

Figure 4.3.5.3.1-5 illustrates the on-hook interruption of full-duplex clear mode traffic for STU-III BDI to STU-III BDI communications. When a user goes on-hook during clear mode traffic, the STU-III BDI shall transmit an EOM followed by Postamble and then release the line, becoming the Leader. The receiving STU-III BDI upon detection of EOM, shall disable its handset, transmit EOM and Postamble then release the line, becoming the Follower.

The Leader shall then send the On-Hook message in half-duplex and go on-hook. The Follower shall send the ACK message in response to reception of the On-Hook message from the Leader, before going on-hook.

Note: The EOM sequences sent by the Leader and Follower shall be transmitted at the BDI line rate, never word stuffed. Also, Clear Mode Control and Go Secure signaling shall be sent at the BDI line rate.

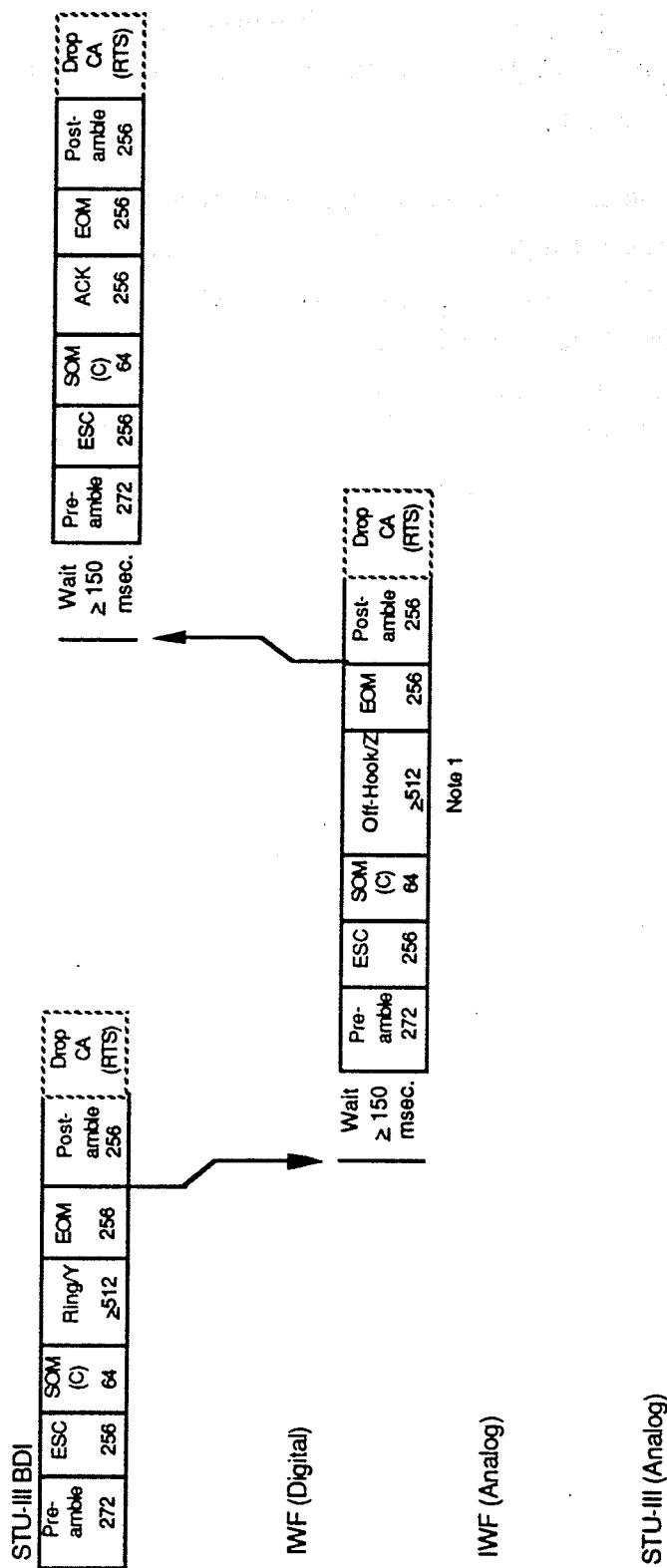
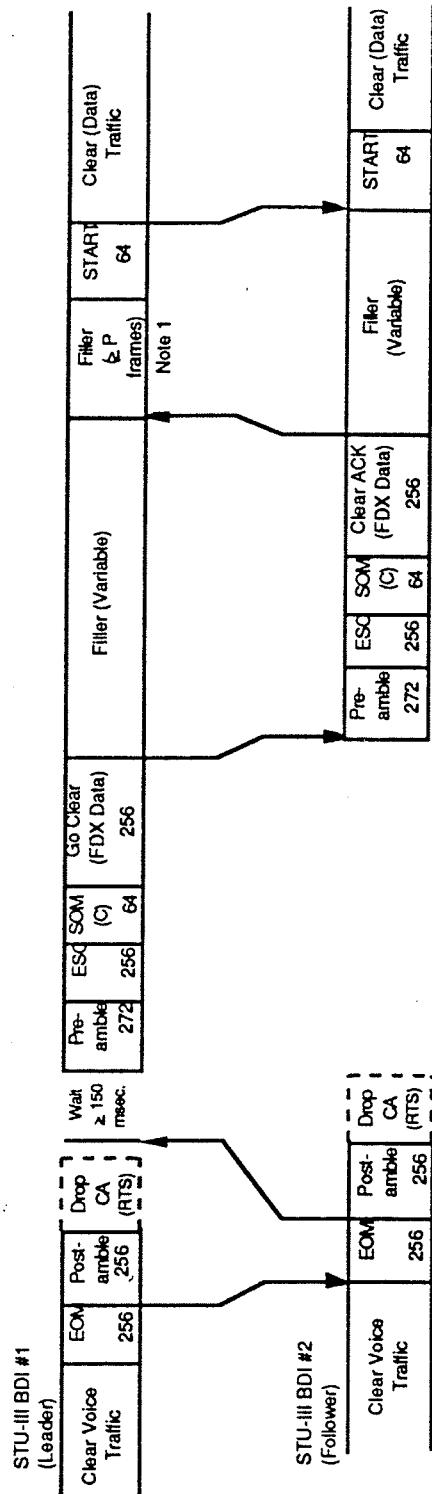


Figure 5.1.1.2.4-1 (a) Full-Duplex Clear Mode Signaling for a STU-III BDI Calling an Analog STU-III



Note 1: P = 4, 9, 19, 24, 28, or 56 frames (prior to any word stuffing or error correction) for the signaling rate of 2400, 4800, 9600, 14400, 16000, or 32000 bps respectively.

Figure 4.3.5.3.1-3 Full-Duplex Clear Voice Escape to Clear Data Signaling for STU-III BDI to STU-III BDI

followed by Preamble, ESC, Start and clear voice traffic, all at the new BDI line rate. The STU-III BDI, upon detection of Preamble from the IWF, shall transmit Preamble, ESC, Start and clear voice traffic, all at the new BDI line rate.

If the selected clear voice rate is less than the line rate, and a circuit CH rate change is not supported, then only a signaling rate change occurs. The STU-III BDI shall, upon completing transmission of the Clear ACK (FDX Voice) message, transmit filler word stuffed or error corrected. The IWF, upon receipt of the Clear ACK (FDX Voice) message, shall transmit at least P frames of filler (see note 4 in Figure 5.1.1.2.4-1), followed by Start and clear voice traffic, all word stuffed or error corrected. The STU-III BDI, upon detection of Start from the IWF, shall transmit Start and clear voice traffic, all word stuffed or error corrected.

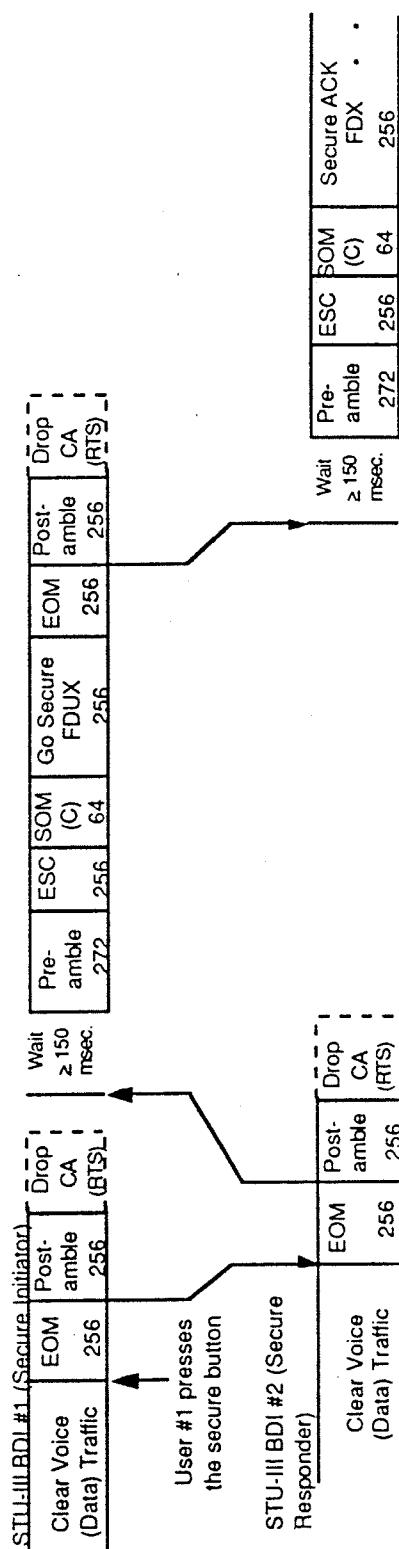


Figure 4.3.5.3.1-4 (a) Full-Duplex Clear Mode Go Secure Interruption Signaling for STU-III BDI to STU-III BDI

Note, if the IWF supports a clear voice mode then it shall provide vocoder to 64 kbps PCM voice, analog voice, etc., signal conversion. This will enable a STU-III BDI terminal with a clear vocoder to communicate with an analog STU-III in a clear voice mode. Section 5.1.2 provides additional details of IWF clear voice mode operation.

5.1.1.2.3 Clear Call Interruptions (MER - OC)

Since the IWF acts as a pass-through device, clear call interruptions will be initiated from one end, either the STU-III BDI terminal or the analog STU-III, not the IWF. Therefore, if the clear mode is implemented, the IWF shall be able to interpret and/or tolerate clear call interruption messages detected on the digital network.

5.1.1.2.4 Full-Duplex Clear Mode Signaling (MER - OC)

The IWF shall support all signaling specified in Section 4.3.5.3.1 for the STU-III BDI clear mode operation. Figure 5.1.1.2.4-1 illustrates the full-duplex clear mode signaling for the scenario in which the STU-III BDI terminal is calling an analog STU-III terminal through an IWF. This timeline assumes two-stage dialing is needed. Therefore, the use of Dial Number and Tone Passthrough may be required. The IWF and STU-III BDI terminal shall exchange standard alerting signaling as specified in Section 4.3.5.3.1, with the STU-III BDI assuming the role of the Clear Responder, and the IWF assuming the role of the Clear Initiator. This shall occur transparent to the analog STU-III. When the IWF receives the Dial Number Message, it shall dial the analog STU-III number on the PSTN. Note that the IWF shall ignore clear voice traffic from the analog STU-III, and shall not transmit clear voice traffic to the analog STU-III until the IWF and the STU-III BDI have completed the exchange of alerting signaling and clear mode control signaling.

If the selected clear voice rate is equal to the line rate, i.e., no rate change is required, the STU-III BDI terminal shall, upon completing transmission of the Clear ACK (FDX Voice) message, transmit filler at the BDI line rate. The IWF, upon receipt of the Clear ACK (FDX Voice) message, shall transmit at least P frames of filler, followed by Start and clear voice traffic. The STU-III BDI, upon detection of Start from the IWF, shall transmit Start and clear voice traffic.

If the selected clear voice rate is less than the line rate, and a circuit CH rate change is supported, the STU-III BDI shall, upon completing transmission of the Clear ACK (FDX Voice) message, transmit filler at the new BDI line rate. The IWF, upon receipt of the Clear ACK (FDX Voice) message, shall transmit at least P frames of filler (see note 4 in Figure 5.1.1.2.4-1),

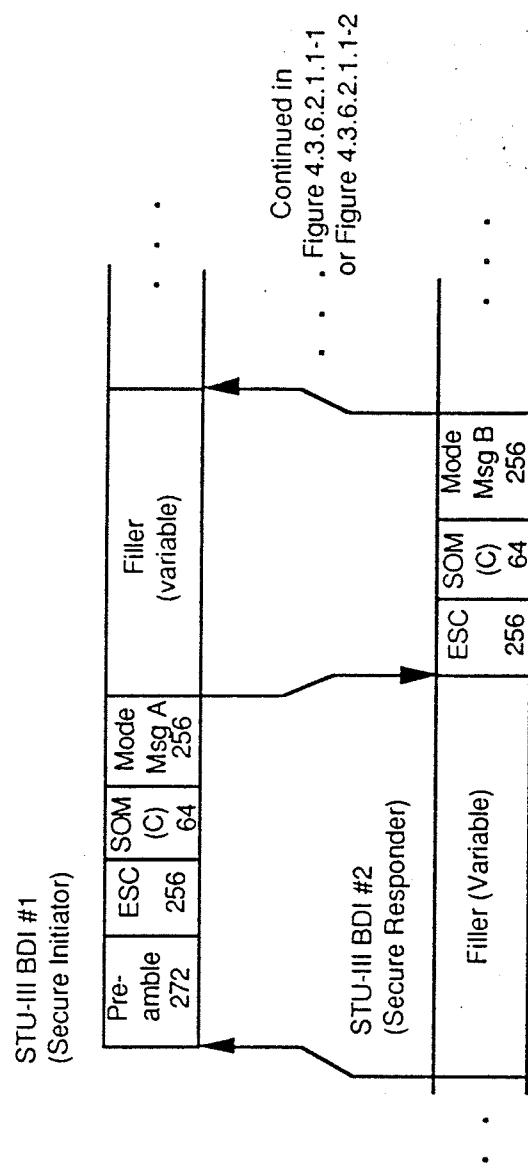


Figure 4.3.5.3.1-4 (b) Full-Duplex Clear Mode Go Secure Interruption Signaling for STU-III BDI to STU-III BDI (Cont.)

The IWF shall distinguish itself from a STU-III BDI terminal by setting the IWF bit (byte 6 bit 1) in the Y and Z messages it transmits. The IWF shall also have a terminal ID which will be set by the manufacturer with an IWF product unique number. The terminal ID is used as a default address for alerting on the digital side of the IWF. This address is formatted as defined in Section 4.3.5.1.1. The alerting address may be programmed to another value by the user, however, it is strongly recommended that this number only be changed by a network administrator, to avoid duplicate addresses.

In addition to the requirements in Section 4.3.5.1, when ring glare involves an IWF, the analog side shall have priority since the analog STU-III has no provision for resolving the glare. There are two basic scenarios:

- 1) an IWF connected to an analog STU-III sends a ring message to a STU-III BDI at the same time the STU-III BDI is ringing the IWF
- 2) an analog STU-III rings the IWF analog side at the same time a STU-III BDI terminal has connected to the IWF digital side and is attempting an outgoing PSTN call.

For the first case, the digital side Ring/Y glare condition, the terminal with the lower source address shall stop sending ring and wait, according to the general glare resolution rule. The terminal with the higher source address shall send the Off-Hook/Z alert to the far-end terminal, anticipating an ACK alert response. In case 2, the analog side shall be answered, and the IWF digital side can optionally connect in the clear mode to the STU-III BDI if it can identify it as the terminal being called by the analog STU-III. Otherwise, the IWF digital side shall send the On-Hook alert message to the calling STU-III BDI and release the digital side. After, the IWF shall proceed with the incoming PSTN call establishment to the intended BDI terminal.

5.1.1.2.2 Clear Call Setup (MER - OC)

The IWF shall optionally support the clear modes as specified in Section 4.3.5.2. The IWF shall also use the Miscellaneous Control Messages when telco or secure capabilities information is to be provided to the terminal on the digital side. These messages are optional and are intended for applications in which the connection between the digital and analog networks is provided as a gateway versus a transparent bridge. In these cases, two-stage dialing may be required, using the Dial Number Message.

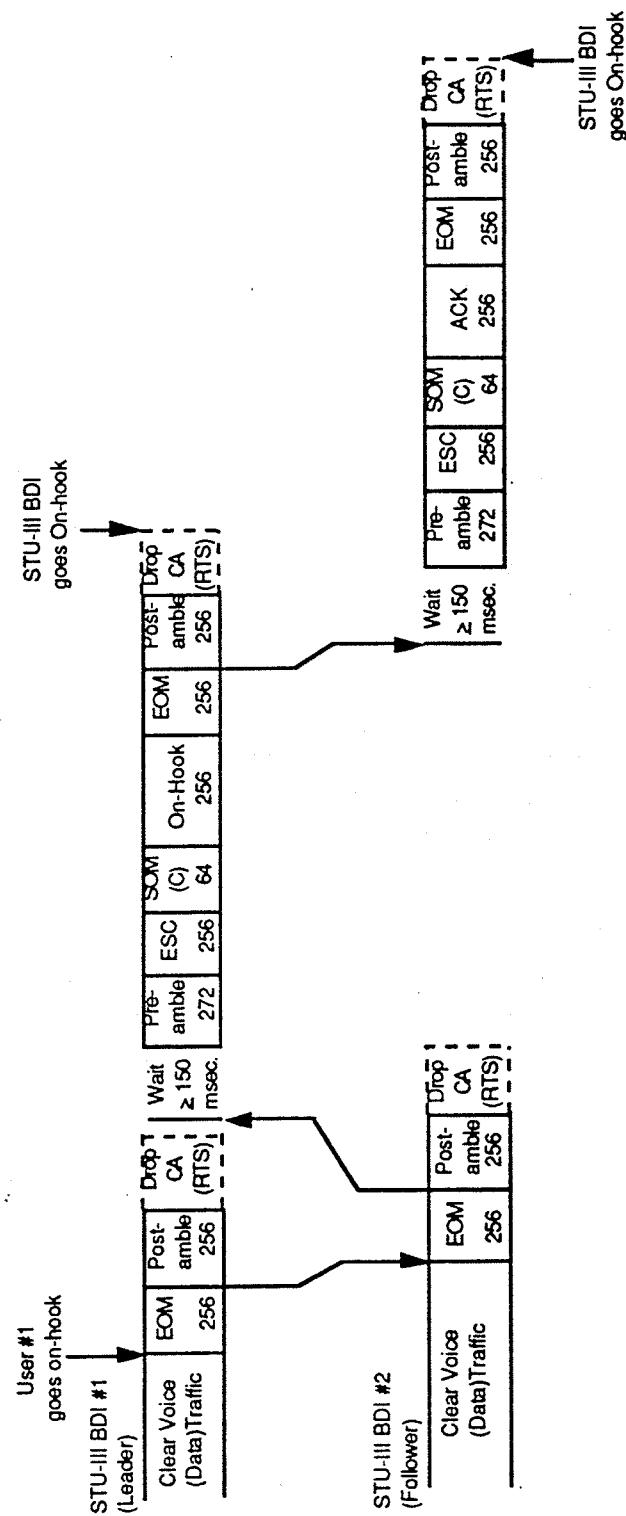


Figure 4.3.5.3.1-5 Full-Duplex Clear Mode On-Hook Interruption Signaling for STU-III BDI to STU-III BDI

initiate call setup at 2400 bps to an IWF which can translate and transmit the messages to a STU-III BDI at 9600 bps utilizing word stuffing. The terminals must negotiate a common traffic rate, but STU-III BDI signaling occurs at the BDI line rate while STU-III signaling depends on the terminal configuration.

Rate control signaling requirements for various scenarios are illustrated in the signaling timelines in Section 5.1.1.3.

5.1.1.4 Timeouts (MER)

Timeouts for the STU-III BDI are specified in Sections 4.3.6.2.1.1.1 and 4.3.6.2.2.3, and timeouts for the analog STU-III are given in FSVS-210. Timeouts relevant to an IWF shall be supported on the digital and analog sides, respectively. This overall requirement prevents an IWF from waiting indefinitely for a response.

5.1.1.5 Call Termination (MER)

When an Interworking Function is used for an analog STU-III to STU-III BDI exchange, call termination shall occur in the same manner as for the analog STU-III, as specified in FSVS-210. For example, in secure signaling as defined in FSVS-210, the Release message is sent when the terminal goes on-hook. If the STU-III nonsecure button is pressed, the Abort message is sent. If a STU-III failure occurs, the Failed Call message is sent. For STU-III BDI to analog STU-III calls through an IWF, the IWF shall pass call termination messages on one side through to the other network. Note that the STU-III BDI Release message is used in the secure mode only, since the On-Hook message serves this purpose in nonsecure modes.

5.1.1.2 Clear Mode Operation

5.1.1.2.1 Alerting (MER)

The alerting protocol is required in the IWF, to accommodate cases where no signaling and supervision is provided by the network. The IWF shall implement all alerting messages as defined in Section 4.3.5.1. The IWF shall not support the alerting protocol on the analog side, only the digital side.

4.3.5.3.2 Half-Duplex Signaling (MER - OC)

The diagrams in this section illustrate the signaling scenarios for the half-duplex clear call modes. Note that the alerting messages are required prior to clear call setup in order to exchange the Y and Z Messages that define the supported capabilities in the clear mode.

The requirements on filler are the same as specified in FSVS-210, page 4-8. That is, filler is always sent as integer multiples of a complete 64-bit message and never truncated. Therefore, the minimum filler shall always be a multiple of 64 bits.

The signaling format for half-duplex STU-III BDI to STU-III BDI clear call setup is shown in Figure 4.3.5.3.2-1. Note that the signaling shown is preceded by the alerting signaling shown in Figure 4.3.5.3.1-1 (a and b). The Clear Initiator transmits first, sending its Go Clear (HDX Voice) message in a single transmission. The transmission is terminated with an End of Message and Postamble.

When the Clear Initiator's first transmission is complete and the line is idle, the Clear Responder transmits its first message, sending the Clear ACK (HDX Voice) message in a single transmission. This transmission is also terminated with an End of Message and Postamble.

In the event that a glare condition should occur while attempting to enter the HDX clear mode (i.e., both STU-III BDI terminals transmit Go Clear HDX at approximately the same time) the terminal with the lower digital source address shall become the HDX clear mode Initiator. The other terminal shall then become the HDX clear mode Responder.

Figure 4.3.5.3.2-2 illustrates an escape from half-duplex clear voice traffic to a half-duplex clear data mode (could also be clear data to clear voice) for STU-III BDI to STU-III BDI communications. If a user selects clear data while receiving clear voice, the STU-III BDI shall wait for release of the line, then transmit Preamble, Escape, SOM, and Go Clear (HDX Data or Voice) followed by Escape and Postamble, and release the line, becoming the Leader. The receiving STU-III BDI shall wait for release of the line and then transmit Preamble, Escape, SOM, and Clear ACK (HDX Data or Voice) followed by Escape and Postamble, becoming the Follower. If data or voice is available for transmission, the terminals will alternate sending half duplex formatted clear traffic. Otherwise, both terminals shall idle until data (voice) is available.

5.1.1.1.3 Rate Control (MER and OC)

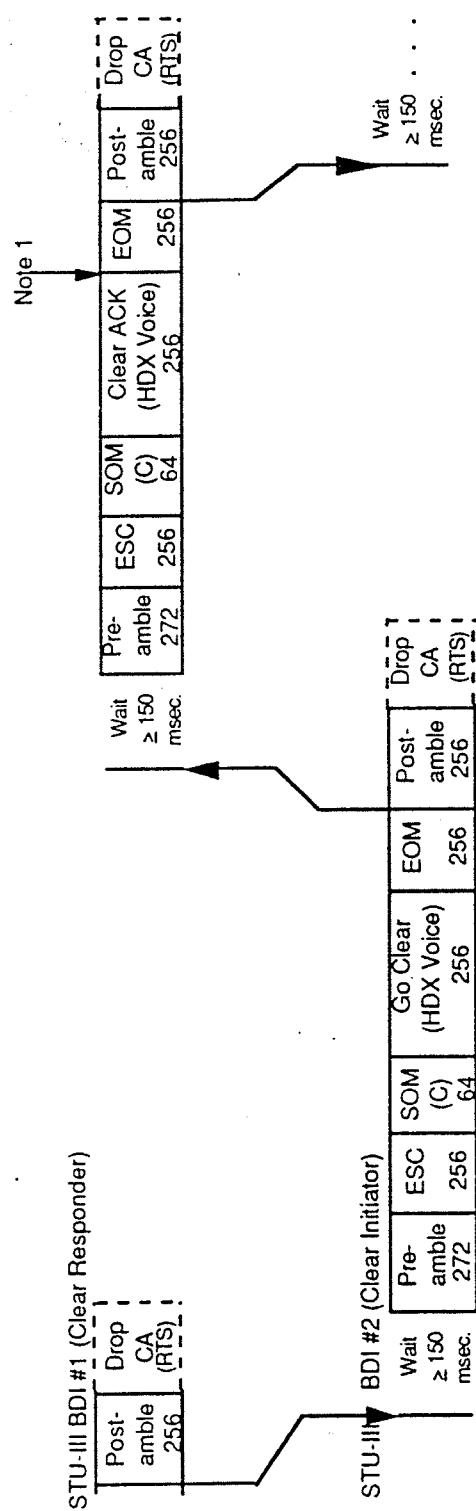
The Interworking Function supports analog/digital secure voice and data at a common information rate between an analog STU-III and a STU-III BDI terminal. On the analog side the STU-III transmissions occur at the signaling rate. The digital side line rate, however, may differ from the information rate depending upon the characteristics of the digital network involved. In addition, a retrain or fallback operation may necessitate a signaling rate change over a digital network that is incapable of line rate changes. For example, a STU-III BDI terminal may support multiple BDI line rates, but may be connected to a network providing a 4800 bps connection only. Thus, the terminal requires a technique to communicate via an IWF with a STU-III having 2400 bps only.

To accommodate line and signaling rate variations, EIA/TIA-232 line rate changes and rate adaption have been specified in Sections 4.2.3.12 and 4.3.6.2.5, respectively. The IWF digital side shall support these methods of rate control in the same manner as specified for the STU-III BDI terminal, that is, the IWF BDI shall support rate adaption (word stuffing) to 2400 bps in any IWF providing line rates above 2400 bps. Rate adaption to other rates using word stuffing or error correction and BDI line rate control are Optional Capabilities. Since the analog STU-III does not support rate adaption, the IWF analog side does not require this capability.

For the case in which an IWF supports both circuit CH line rate changes and rate adaption, rate control on the digital side shall follow the procedures set forth in Section 4.3.6.2.5. The characteristics of the specific digital network for which the IWF is designed will determine the rate control configuration needed. For example, a STU-III BDI terminal connected to a DCE providing only a 4800 bps line rate must perform rate adaption to support 2400 bps signaling. If the DCE supports both 2400 and 4800 bps, then rate adaption is not necessary as long as circuit CH line rate changes are supported and enabled at both ends.

For a digital link rate not supported by the STU-III specification, rate control is not specified herein, and therefore, adaption to a STU-III compatible rate must be provided by other application-specific means. A STU-III BDI connected to a digital cellular network is an example of a system requiring specialized rate adaption.

Note that while clear and secure mode traffic must be exchanged at a common information rate, there is no such requirement for signaling in general. For example, an analog STU-III may



Note 1: alternatively, if the clear responder has traffic ready for transmission it may transmit P frames of filler (prior to word stuffing) followed by START and traffic, where $P = 4, 9, 19, 24, 28, \text{ or } 56$ frames for the signalling rate of 2400, 4800, 9600, 14400, 16000, or 32000 bps respectively.

Note 2: If the clear mode to be entered is the HDX Idle mode, the signaling shall be as shown in part (a) of this Figure only. Part (b) of this Figure is not applicable to the HDX Idle case.

Figure 4.3.5.3.2-1 (a) Half-Duplex Clear Mode Signaling for STU-III BDI to STU-III BDI

In addition buffering may be required to account for timing differences between the two networks. Additional buffering may be needed to prevent loss of cryptographic synchronization. However, this is at the expense of added delay. A minimum duration of ten minutes before cryptographic resynchronization is highly recommended, provided this does not introduce other anomalies due to excessive delay.

5.1.1.1 Mode Independent Requirements

5.1.1.1.1 Message Scrambling (MER and OC)

To avoid discontinuous scrambling, it is strongly recommended that the IWF perform descrambling of inputs and rescrambling before output, for both digital to analog and analog to digital transmissions. In addition, with the use of filler regeneration, the IWF may prevent disjoint filler between variably timed messages. Nevertheless, IWF products may produce disjoint filler transmissions to STU-III BDI terminals.

Message scrambling at the IWF shall comply with FSVS-210 on the analog side and STU-III BDI conventions on the digital side. Therefore, all digital side clear call mode messaging, including alerting and clear mode negotiation, shall use the Initiator SOM(C) and GPC scrambling, since the secure Initiator and Responder roles are not yet established. The secure call setup messages shall use either the Initiator SOM(C) and GPC scrambling or Responder SOM(A) and GPA scrambling, depending upon the particular message and the role of the sending terminal. Messages that are the same on both sides of the IWF shall use SOM and scrambling according to FSVS-210 conventions (SOM(C) and GPC scrambling for the Initiator, SOM(A) and GPA scrambling for the Responder). BDI specific messages shall always use SOM(C) and GPC scrambling on the digital side.

5.1.1.1.2 BCH Block Error Control (OC)

Signaling messages are BCH encoded to provide end-to-end error control. This is a systematic code which need not be decoded to extract the data portion of the (error-free) message. As an Optional Capability (OC), an Interworking Function may be designed to decode each BCH block, correct errors if possible, and re-encode the block. This will reduce the compounding of errors from the various digital and analog links. STU-III BDI signaling has been designed to accommodate reasonable delays resulting from error control at the IWF.

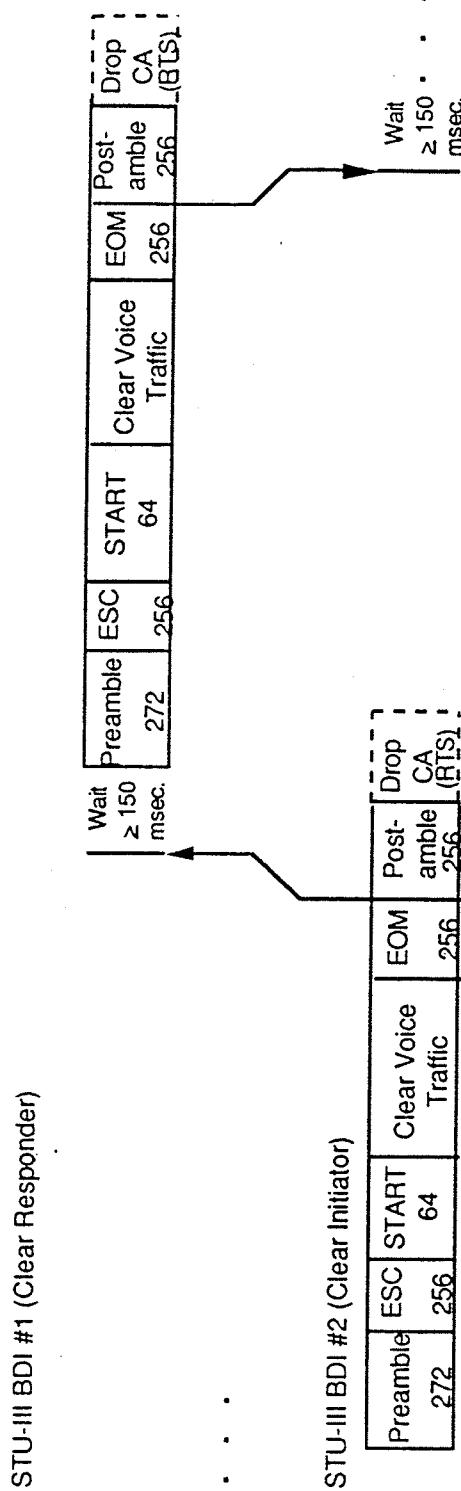


Figure 4.3.5.3.2-1 (b) Half-Duplex Clear Mode Signaling for STU-III BDI to STU-III BDI
(Cont.)

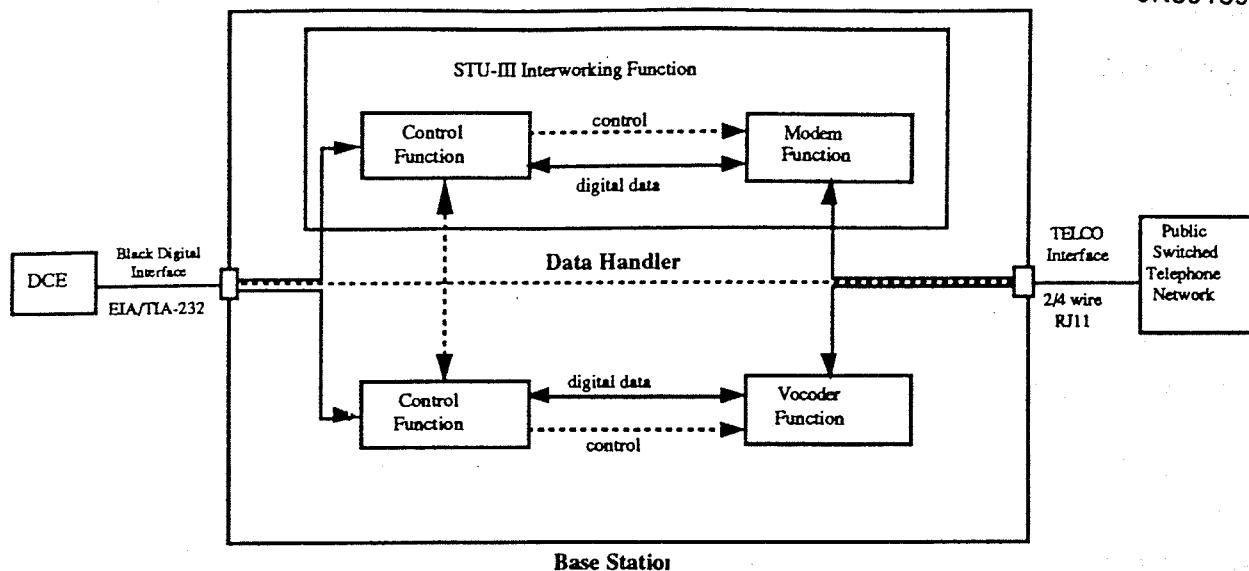


Figure 5.1-1 Digital/Analog Connection Interfaces & High Level Functions

5.1.1 Interworking Function (MER)

The Interworking Function (IWF) provides a mapping of secure Mode Control and Variable Exchange messages between a STU-III BDI on the digital network and a STU-III on the analog network. The mapping between STU-III BDI digital messages and STU-III analog signaling tones must always be implemented.

In many cases, IWF requirements are such that analog STU-III and STU-III BDI terminals can communicate with each other through an IWF just as they would communicate with another terminal of the same type. Exceptions to this rule are described below; otherwise, the IWF is required to appear as a terminal of the same type found on that side of the analog or digital connection. IWF products shall interoperate with all existing FSVS-211 compliant STU-III BDI terminals.

STU-III BDI signaling incorporates extra filler and other accommodations allowing the terminals to communicate with each other when an IWF is in the path. The filler is typically variable, resulting in a less complex STU-III BDI terminal with less critical timing constraints. This shifts a small amount of buffering complexity from the many terminals to the relatively few Interworking Functions. STU-III BDI terminals pass messages as soon as they are ready to send; the IWF shall buffer messages if necessary to accommodate the far end signaling requirements.

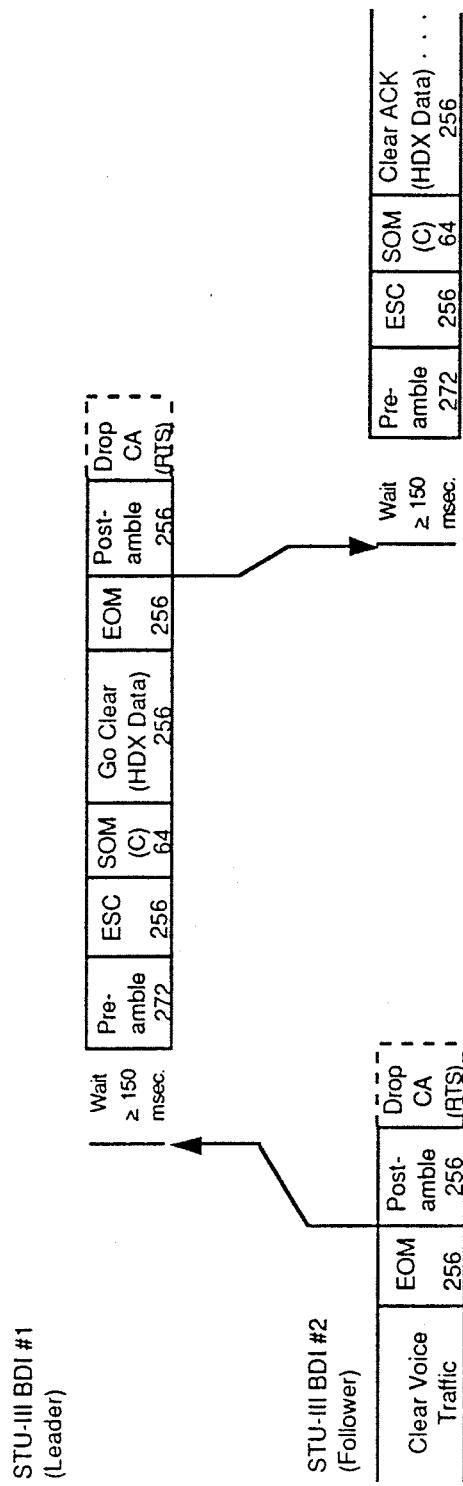


Figure 4.3.5.3.2-2 (a) Half-Duplex Clear Voice Escape to Clear Data Signaling for STU-III BDI to STU-III BDI

5 INTERWORKING FUNCTION GENERAL INTERFACE REQUIREMENTS

5.1 Digital to Analog Network Connections

For some applications, it will be necessary to provide a connection between a digital network and an analog network. Examples of this are a satellite ground station for the mobile satellite (MSAT) application or the base station for the digital cellular application. At these stations, it is necessary to provide the capability to connect a STU-III BDI terminal on a digital channel, in this case provided by the digital cellular network or the MSAT system, to an analog STU-III connected to the PSTN. The goal is to minimize the special equipment required at the point of connection.

There are three top level functions that should be provided at a digital to analog connection: interworking, vocoder and modem. Each function maps one of three classes of digital signals into the analogous class of analog line signals, and vice versa. The classes and functions are shown in Table 5.1-1. Figure 5.1-1 shows a high level diagram of the interconnections among the three functions.

Digital Signals (DCE side)	Mapping Function	Analog Signals (PSTN side)
Control messages	Interworking	Call setup messages & signaling tones
Clear digital voice	Vocoder	Clear analog voice
Secure voice/data	Modem	Secure voice/data

Table 5.1-1 Analog to Digital Message Mapping

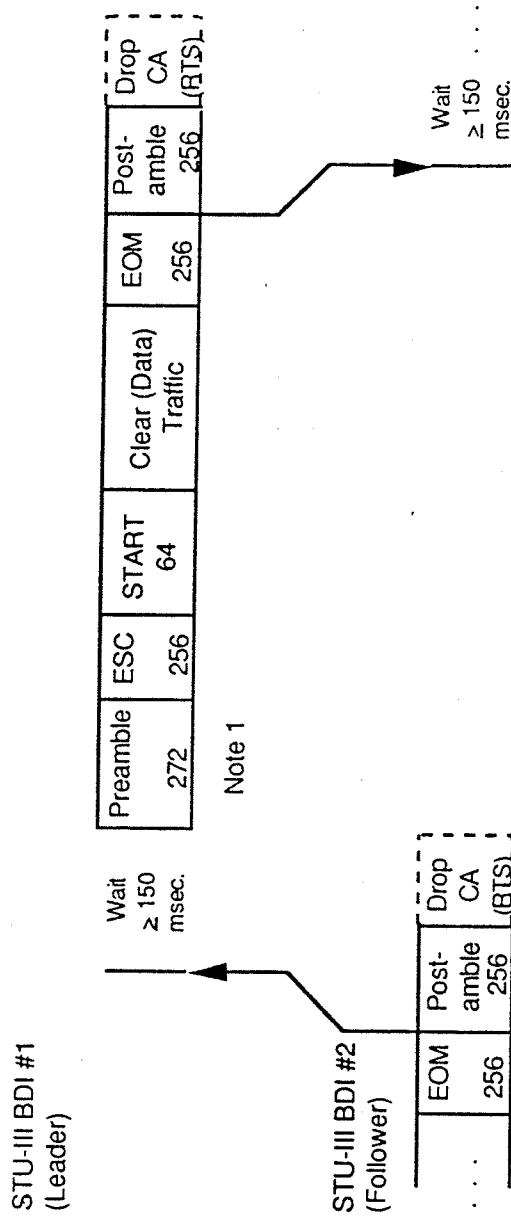
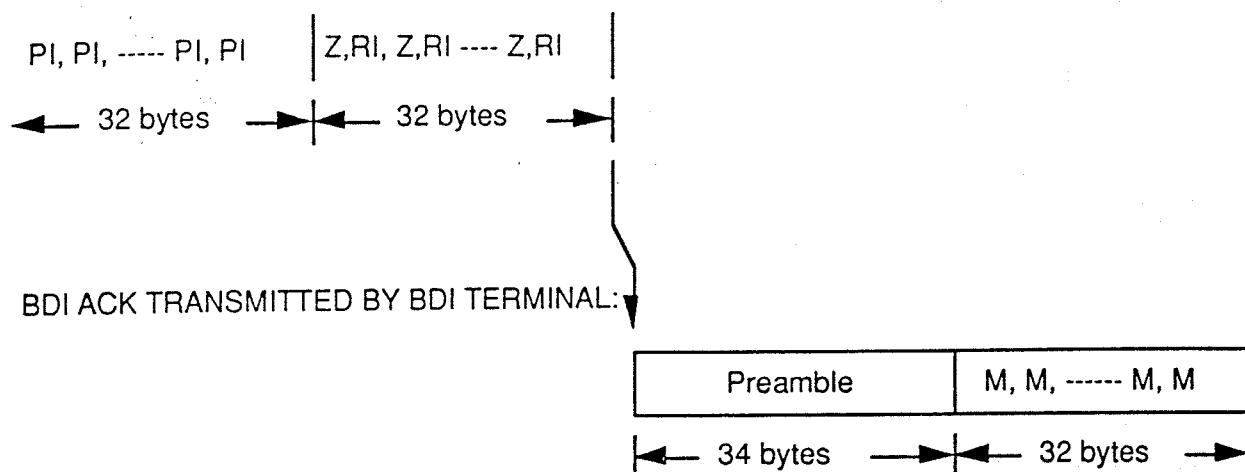


Figure 4.3.5.3.2-2 (b) Half-Duplex Clear Voice Escape to Clear Data Signaling for STU-III BDI to STU-III BDI (Cont.)

STE's SCRQ MESSAGE AS RECEIVED BY STU-III BDI TERMINAL:



MESSAGE FIELD DEFINITIONS:

PI = 0101011100000011 (binary)

Z = 0000000100000001 (binary)

RI = 16-bit initiator random number with LSB of each byte set to "1".

Preamble = 0101011100000011 (binary - same pattern as PI)

M = BDI Secure ACK FDX MID = 0010011001100000 (binary)

Figure 4.3.8-1 STE - BDI Compatibility Signaling

Figure 4.3.5.3.2-3 illustrates an escape from half-duplex clear voice traffic to the on-hook state for STU-III BDI to STU-III BDI communications. The signaling shown would be preceded by that shown in Figure 4.3.5.3.2-1 (a and b). If a user goes on-hook while receiving clear voice, the STU-III BDI shall wait for release of the line, then transmit Preamble, Escape, SOM, and the On-Hook message followed by EOM and Postamble, and release the line, becoming the Leader. The receiving STU-III BDI shall wait for release of the line and then transmit Preamble, Escape, SOM, and the ACK message followed by EOM and Postamble, becoming the Follower.

4.3.5.4 Clear Voice Modes (MER and OC)

Any STU-III BDI, implementing a clear voice or data mode, shall support either half-duplex or full duplex (depending upon the network) 2400 bps clear voice, using the LPC-10e vocoder. Also, it may optionally support any other clear vocoder listed in Table 4.3.5.4-1. In addition, any vendor may choose to implement a proprietary vocoder voice mode which would require a bit assignment in the Y and Z Messages.

Clear Voice Mode and Rate	Vocoder
2400 bps HDX	LPC-10e
4800 bps HDX	CELP
4800 bps HDX	RCELP
9600 bps HDX	MRELP
16000 bps HDX	CVSD
32000 bps HDX	CVSD
2400 bps FDX	LPC-10e
4800 bps FDX	CELP
4800 bps FDX	RCELP
9600 bps FDX	MRELP
16000 bps FDX	CVSD
32000 bps FDX	CVSD

Table 4.3.5.4-1 Clear Voice Mode Vocoders and Rates

bytes of preamble (same as the STE PI pattern, except two bytes longer) followed by 32 bytes (16 repeats) of the SECURE ACK FDX message MID (without data/parity field and BCH encoding). Data patterns for all message fields are specified in Figure 4.3.8-1. A STE that receives the BDI ACK message in response to its SCRQ message will switch to STU-III BDI signaling, transmit the Ring/Y message, and then continue with STU-III BDI signaling using STU-III encryption.

A STE terminal that is connected to a narrowband digital network either directly or through an interworking function will respond automatically to either STE secure initiation signaling or STU-III BDI signaling. When the STE detects BDI signaling (either Ring/Y or a BDI secure message), it will automatically switch to the STU-III BDI mode of operation and continue with secure call setup using STU-III BDI signaling and STU-III encryption. If a STE is deployed within a narrowband digital network which contains BDI terminals, the STE shall perform BDI alerting when communicating with the BDI terminals, including clear mode capabilities exchange (Y and Z messages), in the same manner as specified in Section 4.3.5.1 for STU-III BDI terminals. Alerting is not supported end to end through an IWF, but will be required on the narrowband digital network. In this case, the IWF will perform separate signaling on each network, communicating with a BDI terminal on one end, including alerting, and a STE terminal on the other, without alerting.

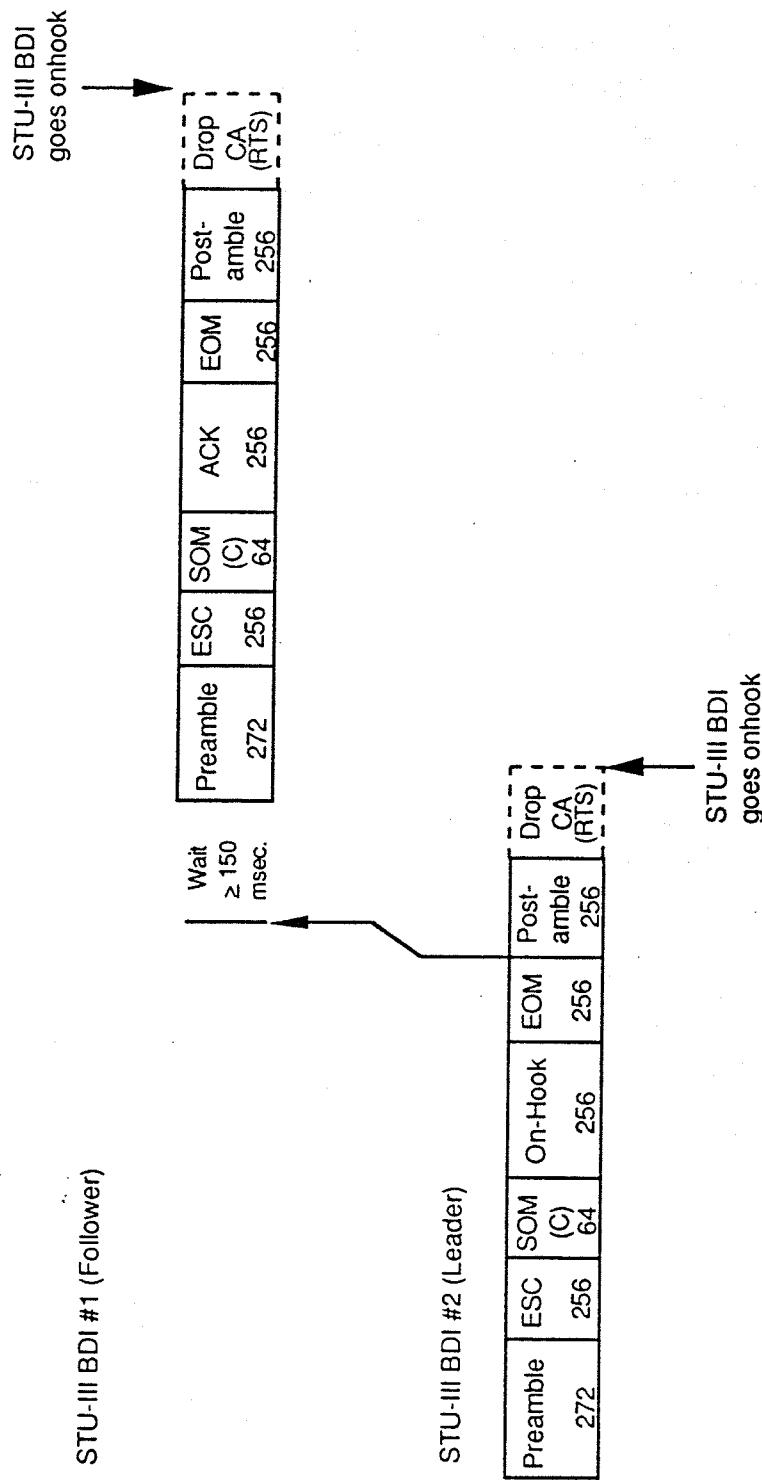


Figure 4.3.5.3.2-3 Half-Duplex Clear Mode On-hook Interruption Signaling for STU-III BDI to STU-III BDI

4.3.7 STU-III BDI/Key Management Center Interaction (MER)

This section provides the additional requirements for the interaction between the Key Management Center (KMC) and the STU-III BDI during a rekey call. Terminals implementing the STU-III Black Digital Interface shall support half duplex rekey operation via the BDI. This will involve communication through an IWF to the KMC. The STU-III BDI shall comply with all requirements as defined in FSVS-210 Section 2.3, STU-III/Key Management Center (KMC) Interaction.

When making a rekey call, the BDI terminal shall have all call setup signaling timeouts extended an additional 6.0 seconds, if the Extended Timeout Mode is enabled. These timeouts are listed in Table 4.3.6.2.2.3-1 "Half Duplex Timeouts," column C. Also, during secure rekey traffic, there is a timeout associated with the duration of time that the STU-III must wait to receive a message from the KMC. The STU-III BDI starts this timer when it has completed transmitting an RK ACK or CKL ACK message, or has received an Idle message from the KMC. Currently, this timer is set for 10.0 seconds in analog STU-IIIs. BDI terminals shall extend this timeout to at least 16.0 seconds for all rekey traffic messaging. This message timeout may be user selectable, but shall always be set to at least 16.0 seconds. It is strongly recommended that if this timeout be made user selectable, that it only be changed by a network administrator.

Timing diagrams of the signaling for BDI rekey operation via an IWF are provided in Section 5.1.1.4, STU-III BDI/KMC Rekey Call Setup.

4.3.8 Compatibility with Secure Terminal Equipment (STE) (MER)

While terminals implementing the STU-III Black Digital Interface are cryptographically incompatible with STE terminals in their primary mode of operation, each terminal must recognize the other terminal's secure initiation signaling and respond in a manner that will allow secure call setup to proceed using STU-III BDI signaling and STU-III encryption. This shall be accomplished as follows.

When a secure call is initiated from a STE terminal operating in its primary mode, the STE terminal will transmit a secure initiation signal, SCRQ. The STE secure initiation signal, shown in Figure 4.3.8-1, consists of 32 bytes (16 repeats) of the initiator pattern (PI) followed by 32 bytes of alternating Z and RI sequences, each of which are two bytes in length. When a STU-III BDI terminal detects this signal, it shall respond with the BDI ACK message, consisting of 34

4.3.5.5 Exception Handling (MER - OC)

If the STU-III BDI experiences a fade (of any duration) during alerting or clear call setup, it shall attempt retransmission of the unacknowledged message according to the ACK/NACK Retransmission Protocol. If the fade occurs during clear call traffic and lasts less than ten seconds or DCD is off less than ten seconds, the STU-III BDI shall recover. If the fade occurs during clear call traffic and lasts longer than ten seconds or DCD is off more than ten seconds, the STU-III BDI shall revert to the clear idle state (by sending EOM/Postamble and then dropping carrier) if full duplex or to traffic idle if in half duplex, otherwise recover. The far end, upon reception of EOM/Postamble or recognition of a fade, shall send EOM/Postamble and drop carrier, reverting to the clear idle state. Also, if full duplex, the STU-III BDI, that initiated the revert to clear idle, shall initiate the previous clear mode automatically. If a loss of EIA/TIA-232 signal DSR is experienced, the terminal shall revert to the alerting idle state and go on-hook if the condition persists longer than ten seconds.

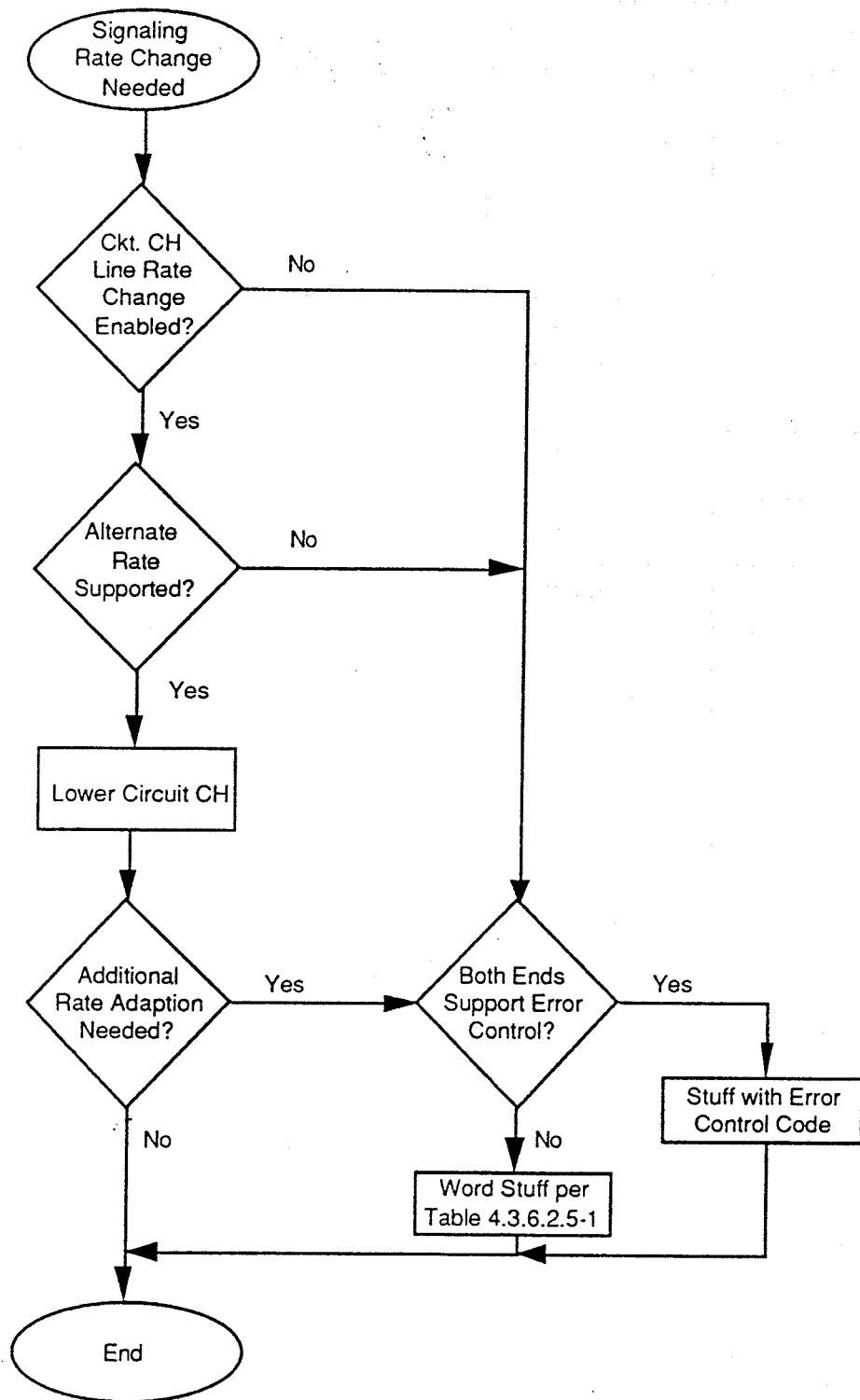


Figure 4.3.6.2.5-1 STU-III BDI Rate Change

4.3.6 Secure Mode Operation

This section specifies the message formats, signaling, and associated requirements for the STU-III BDI terminal secure mode operation. Secure mode is entered either in response to the user activating the secure control, i.e., pressing the Secure button, or automatically if the called terminal is strapped for Auto-Secure operation. The terminal from which secure mode is activated is referred to as the Secure Initiator, and the far-end terminal is the Secure Responder. To conform to conventions established in FSVS-210, the Secure Initiator and Secure Responder will be referred to in the following sections as the Initiator and Responder.

4.3.6.1 Secure Mode Messages

4.3.6.1.1 Secure Call Setup Messages

In general there are two types of messages relating to secure call setup: secure mode control messages and variable exchange messages. Secure mode control messages are utilized in transitioning from clear to secure operation and negotiating a common secure mode. Variable exchange messages are utilized in the cryptographic synchronization process. Both types of messages are described below.

4.3.6.1.1.1 Secure Mode Control Messages (MER - OC)

Seven messages are defined for controlling the STU-III BDI terminal secure mode selection process. These replace the call setup tones and Message A/Message B used in the analog STU-III. They are referred to herein as secure mode control messages, and are shown in Table 4.3.6.1.1.1-1. Secure mode control messages shall always be transmitted in complete BCH blocks and scrambled using the GPC scrambler when transmitted by either the Initiator or Responder terminal. Secure mode control messages transmitted by the Initiator and Responder shall be preceded by the Initiator SOM, designated SOM(C), as defined in Reference 1.

The *Go Secure Half-Duplex* or the *Go Secure Full-Duplex* message shall be transmitted by the Initiator when the user presses the secure button, depending on whether the STU-III BDI terminal is configured for half or full-duplex operation, respectively. The data field of the Go Secure Half-Duplex message shall consist of a one-byte ASCII character ("I" for "far-end shall become initiator" or "R" for "far-end shall become responder", both capitalized) and thirteen unused data bytes set to all hex zeros. The data field of the Go Secure Full-Duplex message shall

Signaling Rate (bps)	Network Interface (bps)	Rate Adaption Pattern
2400 / 4800/16000	4800 / 9600/32000	1011 0100 0011 0110
2400	9600	0010 1101 1110 0001 0101 1010 1100 0110 0011 0100 1011 0111
2400	14400	TBD
2400/4800	16000/32000	TBD
2400	32000	TBD
4800	14400	TBD
4800/9600	16000/32000	TBD
4800	32000	TBD
9600	14400	TBD
9600	16000	TBD
9600	32000	TBD
14400	16000	TBD
14400	32000	TBD
<i>Table 4.3.6.2.5-1 Word Stuffing Rate Adaption Patterns</i>		

be all hex zeros. (Note: As an option, the last seven bytes of the data field in the Go Secure Half-Duplex and Go Secure Full-Duplex messages may contain the Source address as specified in Section 4.3.1.2.)

Message	MID (Hex)
Go Secure Half Duplex	2330
Go Secure Full Duplex	2550
Secure ACK FDX	2660
Mode Message A	2880
Mode Message B	2990
IWF Status	2440
BDI Secure ACK	See Below

Table 4.3.6.1.1.1-1 *Secure Mode Control Messages*

The *Secure ACK FDX* message is transmitted by the STU-III BDI terminal to confirm the reception of the Go Secure Full Duplex message. The data field of the Secure ACK FDX message shall be all zeros. (Note: As an option, the last seven bytes of the data field in the Secure ACK FDX message may contain the Source address as specified in Section 4.3.1.2.)

The *Mode Message A* and *Mode Message B* messages carry the alternate mode information in the first N bytes of the data field. The remaining bytes are all sent as hex zeros. The format, content, and number (N) of these bytes are identical to that specified in §2.2.1.2.1 and §2.2.1.2.2 of Reference 1 for Message A and Message B, respectively. In particular, the first byte begins with three synchronization bits; these are retained for compatibility, even though they are superfluous for the STU-III BDI. (Note: As an option, the last seven bytes of the data field in the Mode Message A and Mode Message B messages may contain the Source address as specified in Section 4.3.1.2.)

The *IWF Status* message is transmitted by the IWF to inform the STU-III BDI terminal of the secure mode selection after the Message A/B exchange on the analog side. The signaling for STU-III BDI to IWF using the IWF Status message is specified in Section 5.1.1.3. The IWF Status message has the same format as Mode Message B.

4.3.6.2.5 Rate Adaption (MER and OC)

Changing the signaling rate of the STU-III BDI interface is accomplished by either changing the line rate (RS-232 circuit CH), or rate adaption (via word stuffing or error correction) or both. Signaling rates other than 2400 bps are optional, however STU-III BDIs that support BDI line rates above 2400 bps shall support rate adaption of 2400 bps signaling, using word stuffing, to all offered BDI line rates. In addition, rate adaption of any other signaling rates, both clear and secure, may be supported as Optional Capabilities. In any case, any clear or secure mode offered in the Y or Z message must be supported via word stuffing rate adaption to any BDI line rate offered in the corresponding Y or Z message. For the defined rate adaption patterns, STU-III BDI word stuffing shall be performed by inserting an integer number of 16-bit words after each 16-bit information word to achieve the desired rate. The inserted words shall contain either the patterns defined in Table 4.3.6.2.5-1 or an error control code. For rate adaption patterns which are TBD, word stuffing patterns will be inserted as necessary. Capabilities for word stuffing and error control shall be indicated in the Y/Z message exchange. (Specific error detection and correction methods have not yet been defined.)

If a rate change is desired, the STU-III BDI shall first attempt to change the line rate if possible. The line rate change is a user selectable optional feature that can be enabled or disabled. For rate adaption, error control coding shall have priority over the patterns in Table 4.3.6.2.5-1.

The STU-III BDI shall only change the rate using circuit CH if both communicating STU-III BDIs support a circuit CH rate change in the Y/Z exchange. If a line rate change is performed by both communicating STU-III BDIs, it still may be necessary to use additional rate adaption to achieve the desired rate (e.g., if the STU-III BDIs fall back from 9600 bps to 2400 bps on a digital network that supports only 9600 bps and 4800 bps). For this case, the STU-III BDI shall drop the line rate to 4800 bps, and then use word stuffing as defined in Table 4.3.6.2.5-1 or error control codes to achieve a rate of 2400 bps.

If either end does not support the desired line rate using circuit CH, then the STU-III BDI shall use rate adaption (word stuffing or error correction) for a rate change. The STU-III BDI performs word stuffing by inserting an integer number of words containing the rate adaption patterns specified in Table 4.3.6.2.5-1 or an error control code after each word of user information. The logic defined for STU-III BDI rate changes is illustrated in Figure 4.3.6.2.5-1.

The *BDI Secure ACK* message is transmitted by the STU-III BDI terminal upon receipt of the Secure Terminal Equipment (STE) secure initiation signal, SCRQ. It consists of Preamble plus 16 repetitions of the Secure ACK FDX MID; it is not a BCH-encoded message, and as such, does not have its own unique MID. The signaling for STU-III BDI to STE compatibility is specified in Section 4.3.8.

Figure 4.3.6.1.1.1-1 shows a state diagram for the analog STU-III mode selection process, starting with the decision by one terminal to go secure. (It thus becomes the Initiator. The other terminal can take over as Initiator only by rejecting full-duplex and requiring half-duplex.) The figure represents a simplification of Figures 2-2 and 2-43 of Reference 1 (plus some additional information from the text of Reference 1) in that it does not indicate the mechanisms by which a call can fail, and it omits the processes for training equalizers and establishing crypto synchronization. Training equalizers is not relevant to the black digital interface; it is assumed that this function, if necessary, will be provided by the digital communications system. Crypto synchronization is discussed below.

Figure 4.3.6.1.1.1-1 also does not show the details of the time sequence of events during call setup. (This is provided in Section 4.3.6.2, STU-III BDI Secure Signaling.) In particular, the P1800 Hz in response to ESD/ESCD begins before the latter ends. What it does show is the sequence of exchange of these supervisory components. Figure 4.3.6.1.1.1-2 shows an equivalent state diagram for STU-III BDI to BDI communication, using the seven secure mode control messages listed in Table 4.3.6.1.1.1-1. It should be noted that Figure 4.3.6.1.1.1-2 allows for a terminal receiving a Go Secure Full-Duplex message to become a half-duplex Initiator by sending the Go Secure Half-Duplex message instead of the Secure ACK FDX message. This is analogous to the switch from full-duplex Responder to half-duplex Initiator by the analog STU-III.

It should also be noted that *Mode Message A* and *Mode Message B* are always transmitted in full-duplex mode between two BDI terminals, even if operation is constrained to the 2400 bps mode. This is required for communicating the operating mode and data rate between STU-III BDI terminals. For the case where a STU-III BDI is communicating with an analog STU-III through an interworking function, the interworking function shall transmit the IWF Status message to the BDI terminal after any Message A/B exchange on the analog side. Section 5.1.1.3 specifies the secure call setup signaling through an IWF.

Analog STU-III	Digital STU-III BDI
2100 Hz ESD/ESCD	Go Secure FDX
P1800 Hz w/gap	Go Secure HDX
P1800 Hz (with or without phase revs.)	Secure ACK FDX
Message 'A'	Mode Message 'A'
Message 'B'	Mode Message 'B'
<i>no direct equivalent</i>	IWF Status
SCR1	<i>no direct equivalent</i>
<i>no direct equivalent</i>	Preamble/Escape
<i>no direct equivalent</i>	EOM/Postamble
SOM	SOM
Start	Start
EOM	EOM
Filler	Filler
Escape	Escape
Abort	Abort (go nonsecure)
Failed Call	Failed Call
Release	Release (Go On-hook)
Restart Failed Call	Restart Failed Call
Retrain Request	Retrain Request
Retrain ACK	Retrain ACK
Retrain NACK	Retrain NACK
Idle (rekey)	Idle

Table 4.3.6.2.4-1 Summary of the BDI Secure Message Mappings

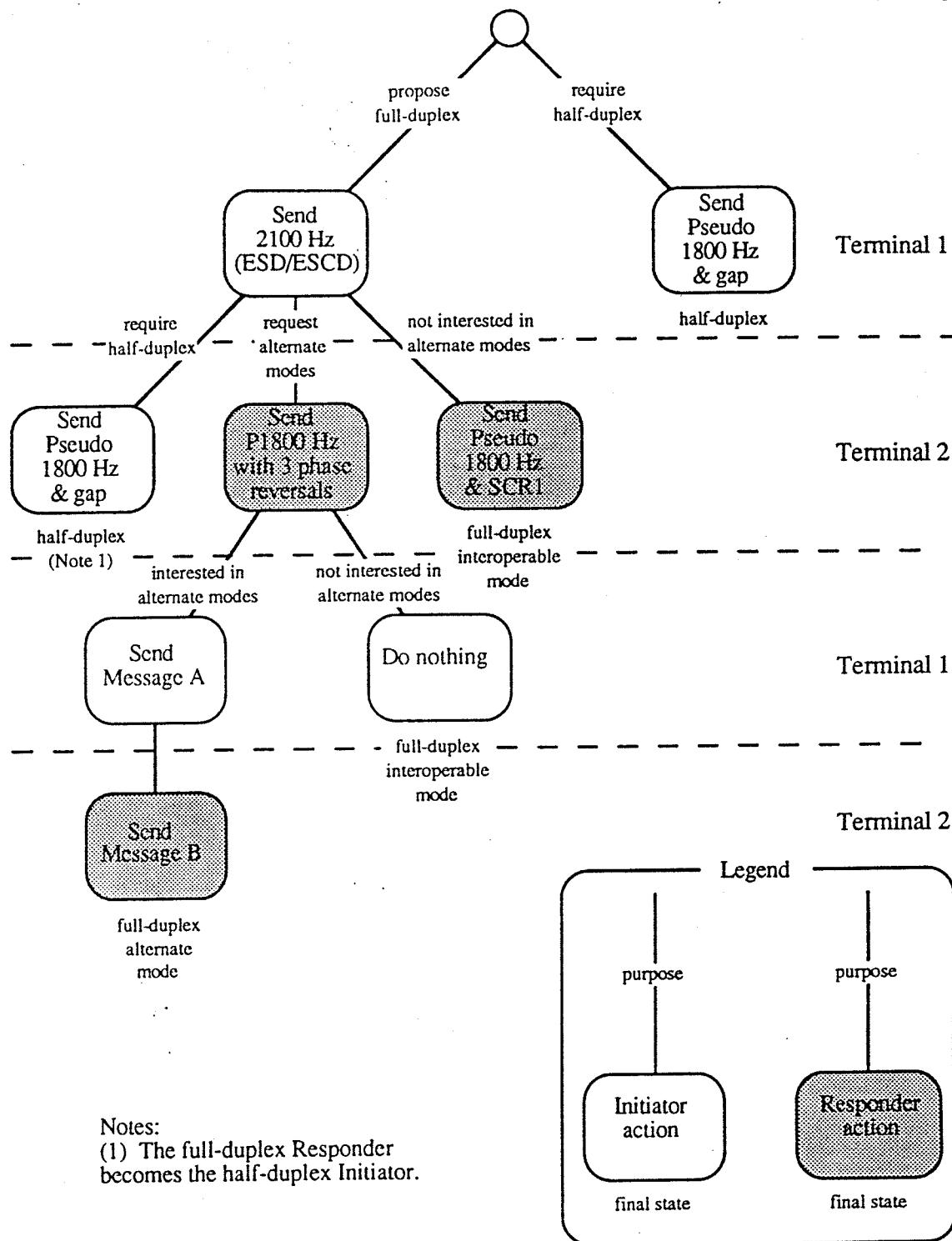


Figure 4.3.6.1.1.1-1 Analog STU-III Mode Selection State Diagram

4.3.6.2.4 STU-III BDI to Analog STU-III Message Mappings (MER)

Table 4.3.6.2.4-1 compares messages used by the analog STU-III family with the messages defined for the STU-III BDI. These mappings shall be maintained to ensure maximum commonality between the two classes of STUs.

The complete set of analog messages and their required digital counterparts are listed in the table. The first five message mappings (2100 Hz ESD/ESCD, P1800 Hz w/ gap, P1800 Hz w/ and w/o phase reversals, Message 'A', and Message 'B') are used in part during the mode selection process. With the STU-III BDI, the same mode selection functions shall be supported by the seven secure mode control messages specified in Table 4.3.6.1.1.1-1 and listed in Table 4.3.6.2.4-1 with their analog counterparts. The functions that SCR1 supports (such as echo suppressor and equalizer training) are not appropriate in the same form for the digital channel, so no direct equivalent is provided for this message. (For example, if a digital channel requires equalization, it is assumed that the data communications equipment supports this function directly through its transmission protocol.)

The next five messages are defined as bit sequences, and occur as part of data traffic. Thus, they are defined for the STU-III BDI to be exactly the same as for the analog STU-III (§4.1 of Reference 1). The SOM and EOM are used in message formatting, as described earlier.

Some of the control messages that a STU-III sends over an analog line are already digital, embedded in a stream of digital voice or data. The *Abort* message is an example. The associated functions shall not require new messages to support them. Instead, the same algorithms used by a STU-III to recognize and act upon such embedded messages when received over the PSTN may be used when the message stream is delivered over the Black Digital Interface. These include the secure call interruption messages defined in table 4.3.6.1.3-1.

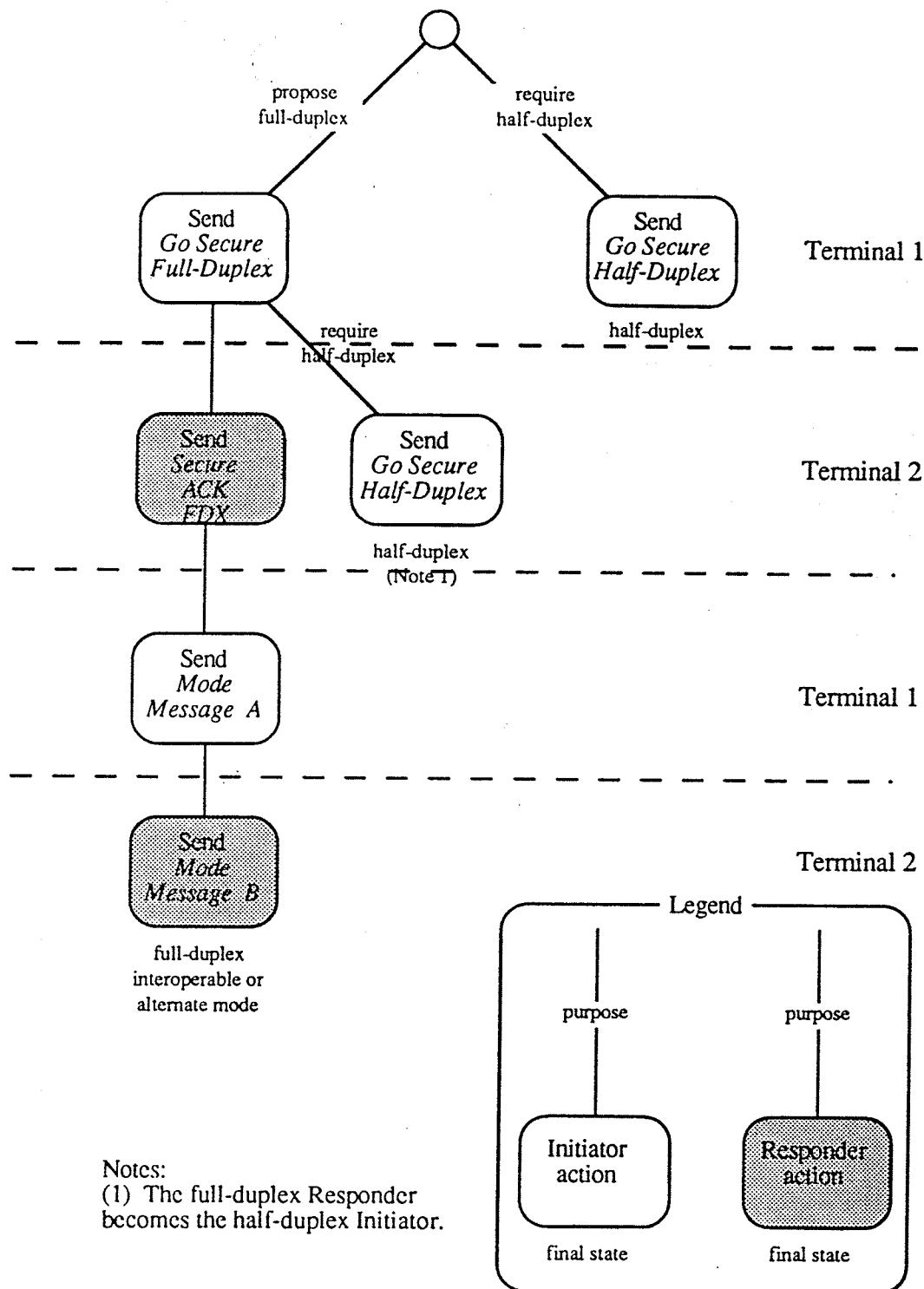


Figure 4.3.6.1.1.1-2 STU-III BDI Mode Selection State Diagram

4.3.6.2.3.2 Out of Sync Detection (MER)

In full-duplex secure voice mode, the STU-III BDI terminal shall recognize a fade by excessive bit errors in the plaintext vocoder receive frames. Specifically, the sync bit should toggle with every frame, and if it does not, the STU-III BDI terminal will detect an out of sync condition. If an out of sync condition is detected, the STU-III BDI terminal shall initiate a cryptographic resynchronization within 10 seconds. The resyncing shall last until the fade condition is no longer present, or until it is terminated by the operator. (A timeout may also be implemented at the manufacturer's discretion.)

4.3.6.2.3.3 Loss of EIA/TIA-232 Signals (MER)

Table 4.3.6.2.3.3-1 shows the response of the STU-III BDI to the loss of DSR, DCD, and RXCLK in each of its modes. In the event of a failed call, the STU-III BDI user may attempt to enter secure mode again. (Note that the notation "FC" in the table refers to an FSVS-210 Failed Call.) Idle, as used in the Table 4.3.6.2.3.3-1, is the state in which the terminal is not receiving a signal.

MODE	DSR	DCD	RXCLK
STU-III HDX Secure Call Setup	Go On-Hook after 10 seconds	idle, FC after 10 seconds	idle, FC after 10 seconds
STU-III HDX Secure Voice	Go On-Hook after 10 seconds	idle	idle
STU-III HDX Secure Data	Go On-Hook after 10 seconds	idle	idle
STU-III FDX Secure Call Setup	Go On-Hook after 10 seconds	FC(if the link was full duplex already)	FC
STU-III FDX Secure Voice	Go On-Hook after 10 seconds	FC after 10 seconds	FC after 10 seconds
STU-III FDX Secure Data	Go On-Hook after 10 seconds	FC after 10 seconds	FC after 10 seconds

Table 4.3.6.2.3.3-1 BDI Response to Loss of EIA/TIA-232 Signals

When a STU-III BDI terminal is communicating with an analog STU-III through an IWF, the Secure Mode Selection process differs from that described above. In order to minimize the effects of delay over both networks linked by an IWF the STU-III BDI terminal's secure capabilities information is passed on to the IWF before any secure call initiation. This enables the IWF to proceed with secure call setup with an analog STU-III without waiting for instruction from the STU-III BDI terminal in response to each message sent from the analog STU-III. This is accomplished using the Secure Capabilities codeword sent in the Y or Z message and/or the Secure Capabilities Message sent by a STU-III BDI terminal. After the Message A/B negotiation with the analog STU-III, the IWF shall transmit the IWF Status Message to the STU-III BDI terminal, notifying it of the secure mode selection.

A STU-III BDI terminal may be configured to support secure voice and data modes up to 14.4 kbps. The set of secure modes supported in a BDI terminal is relayed via the Secure Capabilities codeword sent in either the Y or Z message (byte 9) and the Secure Capabilities Message (byte 1 of the data field). The set of secure modes supported is determined by the dependency tree shown in Figure 4.3.6.1.1.1-3. Selection of a mode shall imply support of all other modes traced up the dependency tree. For example, transmission of the codeword for mode 8 or 9 implies support of modes 1, 2, 3, 4, 5, and 6. Table 4.3.6.1.1.1-2 lists the corresponding codewords for all secure modes. Note, any terminal implementing a new mode shall be required to support modes 1 through 6 if a voice and data mode terminal, or modes 16-19 if a data-only terminal. In cases where it is not clear which common mode to enter, the default shall be voice.

It should also be noted that the Secure Capabilities leader must limit the capabilities it offers by the BDI rate and duplex. This will prevent cases where the terminal requests a rate or mode that the channel will not support; e.g., requesting a FDX secure mode on a HDX BDI link, or requesting a 9600 bps voice mode on a 2400 bps BDI link, etc. If a terminal or IWF should receive a Secure Capabilities message or codeword that indicates an inappropriate mode, the terminals shall follow the branches of the dependency tree (Figure 4.3.6.1.1.1-3) to select a mutually compatible mode.

4.3.6.2.3 Exception Handling

The following sections specify the sequence of events that occur if the STU-III BDI experiences a fade, loss of sync, or a loss of signal.

4.3.6.2.3.1 Fade Bridging (MER)

A fade is defined herein as a condition in which the received data has a very high bit error rate with Received Line Signal Detector, Circuit CF, ON, or a condition in which the Received Line Signal Detector is OFF while the receive clock remains present. The condition of very high bit error rate is detectable by the STU-III BDI terminal in all modes except for data modes. As an option, the STU-III BDI may use the signal quality circuit CG for fade processing, if available. The STU-III BDI will react to a fade differently depending on its current operating state as specified in Table 4.3.6.2.3.1-1.

MODE	RESULT/ RESPONSE
STU-III HDX Secure Call Setup	Secure Call Failed, user may re-attempt call setup
STU-III HDX Secure Voice	Revert to the half-duplex secure traffic idle state if fade is longer than 10 seconds or DCD is off, otherwise recover
STU-III HDX Secure Data	Fade is not recognized
STU-III FDX Secure Call Setup	Retransmit affected message(s) using ACK/NACK protocol as specified in section 4.3.6.2.1.1. If ACK/NACK is unsuccessful, then fail the secure call setup.
STU-III FDX Secure Voice	Attempt resync if fade is shorter than 10 seconds, otherwise fail the secure call
STU-III FDX Secure Data	Fade is not recognized while DCD is present. Fail the secure call if DCD is lost for more than 10 seconds.

Table 4.3.6.2.3.1-1 STU-III BDI Response to Fades

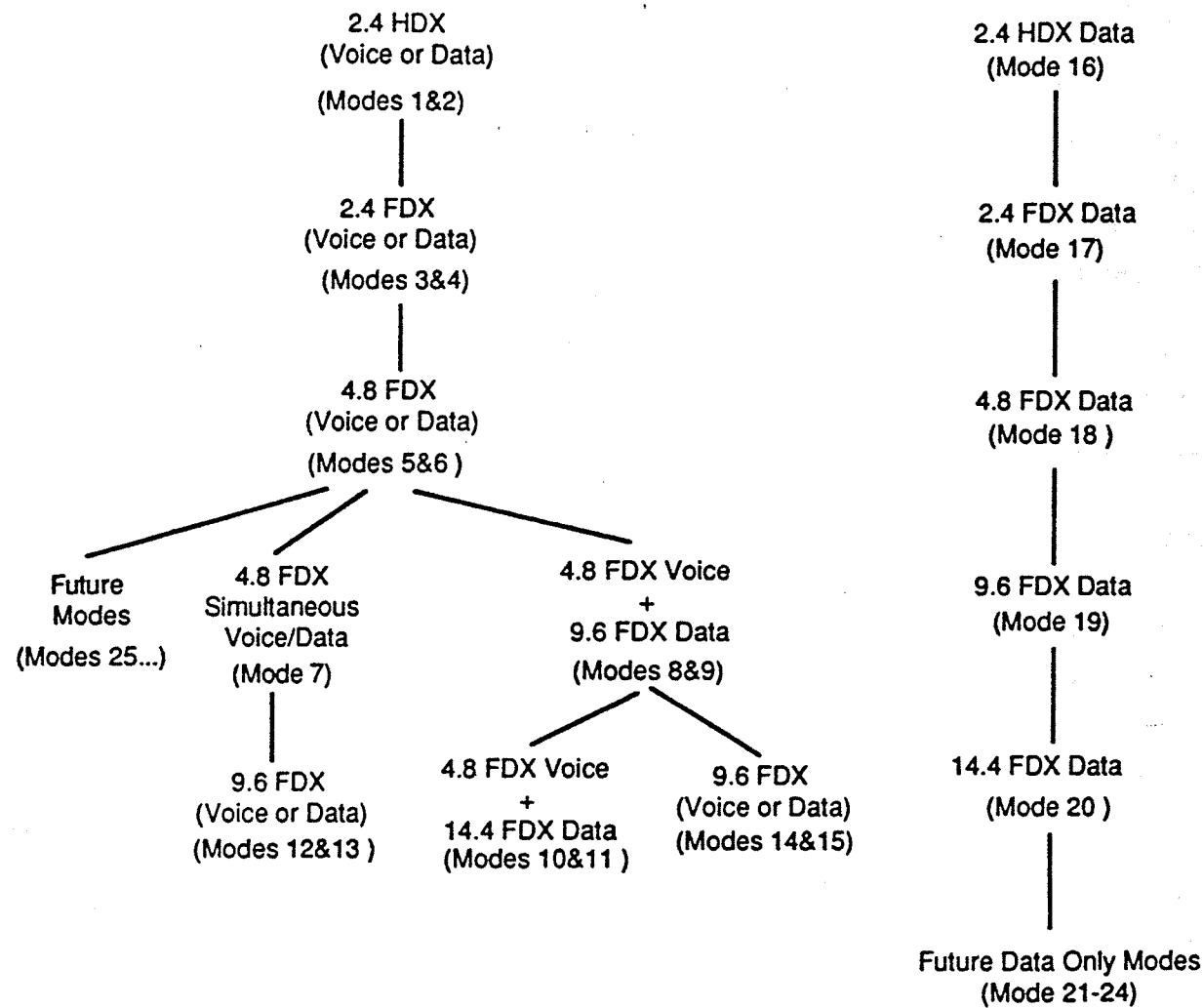


Figure 4.3.6.1.1.1-3 STU-III BDI Secure Mode Capabilities/Selection Dependency Tree

4.3.6.2.2.3 Half-Duplex Timeouts (MER)

The timeouts for the half-duplex mode are derived from those for the analog STU-III given in Reference 1. Definitions of these timeouts are again driven by the requirement to interoperate with analog STU-III's through a digital/analog interworking function. Table 4.3.6.2.2.3-1 is an adaptation of FSVS-210 Table 2-3 with the analog messages and responses replaced by their digital equivalents.

Some STU-III BDI terminals may operate under conditions where the propagation delay is greater than that of the assumed path with three satellite hops. The user-configurable Extended Timeout mode provides an additional six seconds for processing and propagation delays of an unusually long duration. The STU-III BDI terminal user shall be able to enable or disable this feature as desired. Also note, these timeouts with or without extension shall apply to secure call setup for rekey calls as well.

The appropriate terminal, as indicated in column A, shall set a timer at selected points in the call setup as specified in column B. The timer duration is defined in column C. If the timeout is exceeded before the expected message in column D is detected, the terminal shall enter the signaling sequence in column E.

A	B	C	D	E
Terminal Setting Timer	Message Transmitted Starts Timer	Timer Value (Add 6 sec. for Extended Mode)	Expected Response	Response to Timeout
Initiator	Final Bit of EOM after CAP/SV	2.5 ± .6 sec.	Detection of Preamble	Secure Call Failed
Responder	Final Bit of EOM after TC	2.5 ± .6 sec.	Detection of Preamble	Secure Call Failed
Initiator	Final Bit of EOM after RCC	2.5 ± .6 sec.	Detection of Preamble	Secure Call Failed
Responder	Final Bit of EOM after RCC	6.5 ± .6 sec.	Detection of Preamble	Secure Call Failed
Initiator	Final Bit of EOM after CS	4.5 ± .6 sec.	Detection of Preamble	Secure Call Failed
Interworking Function	Final Bit of EOM after Go Secure HDX (Initiator)	TBD	Detection of Preamble	Secure Call Failed
<i>Table 4.3.6.2.2.3-1 Half-Duplex Timeouts</i>				

Mode	STU-III BDI Configuration	Code Word
1	2400 Secure Voice, Half Duplex Mode	0100 000
2	2400 Secure Data, Half Duplex Mode	0100 001
3	2400 Secure Voice, Full Duplex Mode	0100 010
4	2400 Secure Data, Full Duplex Mode	0100 011
5	4800 Secure Voice, Full Duplex Mode	0100 100
6	4800 Secure Data, Full Duplex Mode	0100 101
7	4800 Secure Voice/Data, Full Duplex Mode	0100 110
12	9600 Secure Voice, Full Duplex Mode	0100 111
13	9600 Secure Data, Full Duplex Mode	0101 000
8	4800 Secure Voice, Full Duplex Mode	0101 001
9	9600 Secure Data, Full Duplex Mode	0101 010
10	4800 Secure Voice, Full Duplex Mode	0101 011
11	14400 Secure Data, Full Duplex Mode	0101 100
14	9600 Secure Voice, Full Duplex Mode	0101 101
15	9600 Secure Data, Full Duplex Mode	0101 110
16	2400 Secure Data, Half Duplex Mode	0101 111
17	2400 Secure Data, Full Duplex Mode	0110 000
18	4800 Secure Data, Full Duplex Mode	0110 001
19	9600 Secure Data, Full Duplex Mode	0110 010
20	14400 Secure Data, Full Duplex Mode	0110 011
21-24	Reserved for Data-Only Modes	0110 1xx

Table 4.3.6.1.1.1-2 Secure Mode Capabilities Codewords

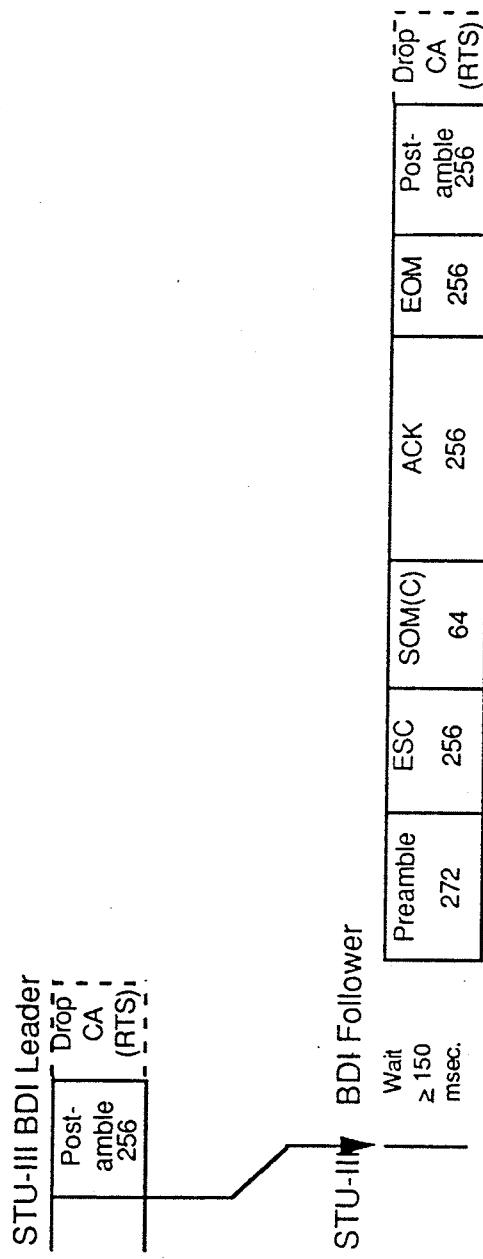


Figure 4.3.6.2.2.2.3-1 (b) Half-Duplex Release Processing (Cont.)

4.3.6.1.1.2 Variable Exchange Messages (MER)

The STU-III BDI variable exchange messages in Table 4.3.6.1.1.2-1 are digital messages that provide the cryptographic information needed for synchronization into secure traffic mode. These messages follow in order after a mode control message is sent. Their transmission format is specified in Section 4.3.1.2. They are identical in content to the corresponding messages specified in Reference 1, and are constrained by the same requirements relating to sequence and timing of transmission for both full-duplex and half-duplex operation. Variable Exchange messages shall always be transmitted in complete BCH blocks and scrambled, using the GPC scrambler when transmitted by the Initiator terminal, and using the GPA scrambler when transmitted by the Responder terminal. Variable Exchange messages transmitted by the Initiator shall be preceded by the Initiator SOM, designated SOM(C); Variable Exchange messages transmitted by the Responder shall be preceded by the Responder SOM, designated SOM(A).

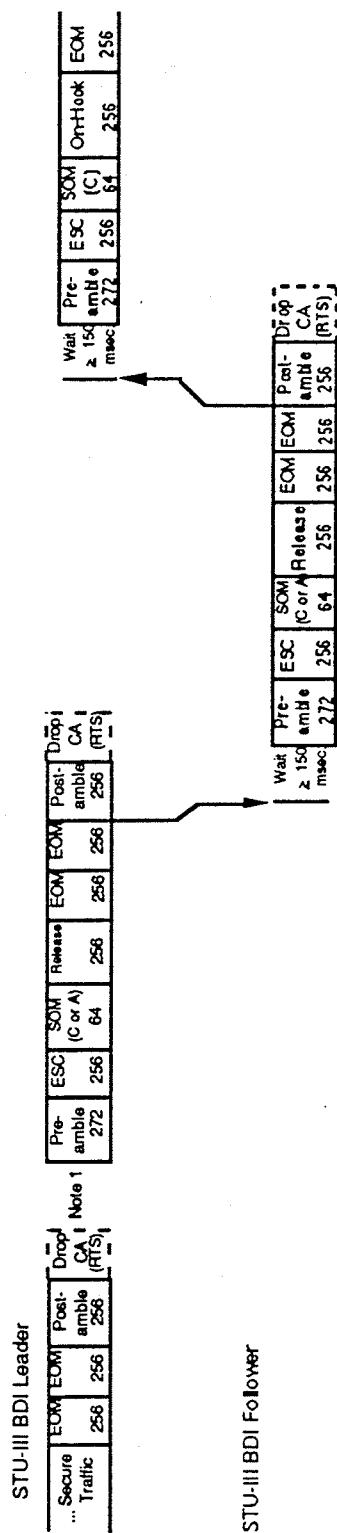
Variable Exchange Messages
Capability/status vector (CAP/SV)
Terminal cipher (TC)
Random component cipher (RCC)
Crypto synchronization (CS)

Table 4.3.6.1.1.2-1 Variable Exchange Messages

This specification requires implementation of the full-duplex ACK/NACK retransmit protocols specified in Reference 1 as optional for the analog STU-III. The implementation shall be constrained by the same requirements as are set forth in Reference 1. The signaling requirements and associated timeouts for the full-duplex ACK/NACK retransmit protocol are specified in Section 4.3.6.2.1.1.

4.3.6.1.1.3 Messages Reserved for Vendors (MER)

Message Identifiers are assigned as required for proprietary use by the terminal vendors. Table 4.3.6.1.1.3-1 below lists the STU-III BDI terminal MIDs reserved for proprietary use. Incorporation of features utilizing these messages shall require prior Government approval. Each message consists of an extensible BCH block with a data field specified by the originating vendor. The lsb of byte 16 (bit 0) shall be the BCH block extensibility bit (set to "1" if an additional block is necessary, "0" otherwise).



Note 1: The Leader terminal must wait a minimum of 75 ms, and a maximum of 1.0 seconds before transmitting the Release message.

Figure 4.3.6.2.2.2.3-1 (a) Half-Duplex Release Processing

Message	MID (Hex)
Martin Marietta Reserved #1	4011
Martin Marietta Reserved #2	4022
Martin Marietta Reserved #3	4033
Martin Marietta Reserved #4	4044
Martin Marietta Reserved #5	4055
Martin Marietta Reserved #6	4066
Martin Marietta Reserved #7	4077
Martin Marietta Reserved #8	4088
Motorola Reserved #1	4000
Motorola Reserved #2	4110
Motorola Reserved #3	4220
Motorola Reserved #4	4330
Motorola Reserved #5	4440
Motorola Reserved #6	4550
Motorola Reserved #7	4660
Motorola Reserved #8	4770
Motorola Reserved #9	4880
Motorola Reserved #10	4990
Motorola Reserved #11	4AA0
Motorola Reserved #12	4BB0
Motorola Reserved #13	4CC0
Motorola Reserved #14	4DD0
Motorola Reserved #15	4EE0
Motorola Reserved #16	4FF0

Table 4.3.6.1.1.3-1 Vendor Reserved Message Identifiers

4.3.6.1.2 Secure Traffic Format (MER)

With full-duplex transmission, secure traffic (voice or data) shall follow the transmission of the final variable exchange message (CS) and the START pattern (same pattern as SOM). Secure traffic is not scrambled. Full-duplex traffic transmissions shall end with an Escape, and SOM followed by a Release, Abort, or Failed Call interruption message (see Section 4.3.6.2.1.3) and EOM/Postamble. The transmission format for full-duplex traffic is shown below.

4.3.6.2.2.3 Half-Duplex Release Processing (MER)

The STU-III BDI terminal shall perform Release Processing when the user places the handset on hook or otherwise disconnects the call. The terminal placed on hook shall assume the role of the Leader and shall wait at least 150 ms after detection of the far-end terminal's second EOM and then transmit Preamble, ESC, followed by SOM(C) or SOM (A), Release, EOM, EOM, and Postamble, and then drop the line. The Follower terminal, upon detection of the Release message, shall wait at least 150 ms after detection of the Leader's second EOM and then shall transmit Preamble, followed by ESC, SOM(A) or SOM (C), Release, EOM, EOM, Postamble, then drop the line and prompt the user to go on hook. Once the Follower terminal has dropped the line, the Leader shall wait between 150 and 1000 ms, and then shall transmit Preamble, followed by ESC, SOM(C), On-Hook, EOM and Postamble. It shall then drop the line and return to the on-hook Idle State. The Follower terminal, at least 150 ms after receipt of the Leader's EOM, shall transmit Preamble, followed by ESC, SOM(C), ACK, EOM, and Postamble. It shall then drop the line and return to the on-hook Idle State, prompting the user to go on-hook. Figure 4.3.6.2.2.3-1 illustrates the signaling/traffic timeline for half-duplex Release processing. Note: The Release sequences sent by the Leader and the Follower shall be transmitted at the current signaling/traffic rate, i.e., the Release sequences shall be transmitted word stuffed or error corrected, if necessary. Alerting signaling (i.e., the On-Hook sequences), however, shall be transmitted at the BDI line rate.

• • • •	SOM 64 bits	CS	Filler (var.)	START 64 bits	Traffic • • •
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Half-duplex traffic is transmitted in discrete messages, one for each transmission. Each transmission shall begin with a Preamble and Escape and end with an FSVS-211 EOM and Postamble as shown below. EOMs sent as part of FSVS-210 signaling shall be transmitted over the digital link in addition to the FSVS-211 EOMs.

No word-stuffing	Subject to word-stuffing							No word-stuffing	
Preamble 272 bits	ESC 256 bits	SOM 64 bits	CS	Filler *	START 64 bits	Traffic (var.)	EOM 256 bits	EOM 256 bits	Postamble 256 bits

* Filler is 4 frames (256 bits) at 2400 bps, 9 frames (576 bits) at 4800 bps, 19 frames (1216 bits) at 9600 bps, 24 frames (1536 bits) at 14400 bps, 28 frames (1792 bits) at 16000 bps, and 56 frames (3584 bits) at 32000 bps, prior to word stuffing.

The preamble shall be as defined for alerting messages. The ESC, SOM, CS, START, and EOM shall be as defined by FSVS-210 (Reference 1). EOM and Postamble shall be as defined for alerting messages. Secure traffic (voice or data) shall begin just after the START pattern of any half-duplex transmission, and shall end with an End of Message field. As with full-duplex transmission, secure traffic is not scrambled.

4.3.6.1.3 Secure Call Interruption and Retrain Messages (MER)

The Secure Call Interruption and Retrain Messages shown in Table 4.3.6.1.3-1 are transmitted when the normal processing of a call is interrupted (e.g., user goes on hook, user presses nonsecure, etc.) and when a retrain is attempted, respectively. The STU-III BDI terminal shall transmit these messages in the same format and under the same conditions as specified in Reference 1, both when the terminal is communicating with another STU-III BDI and when the terminal is communicating with an analog STU-III through an IWF. In addition, the user configurable Extended Timeout Mode shall add an additional 6 seconds to the timeouts specified for these messages in FSVS-210 also. Secure call interruption messages shall be transmitted only during secure call setup or while secure traffic is being processed. For the STU-III BDI, the beginning of secure call setup is defined as the transmission of the first bit of the SOM(C) prior to the Go Secure message for the Initiator terminal, and as the transmission of the first bit of the

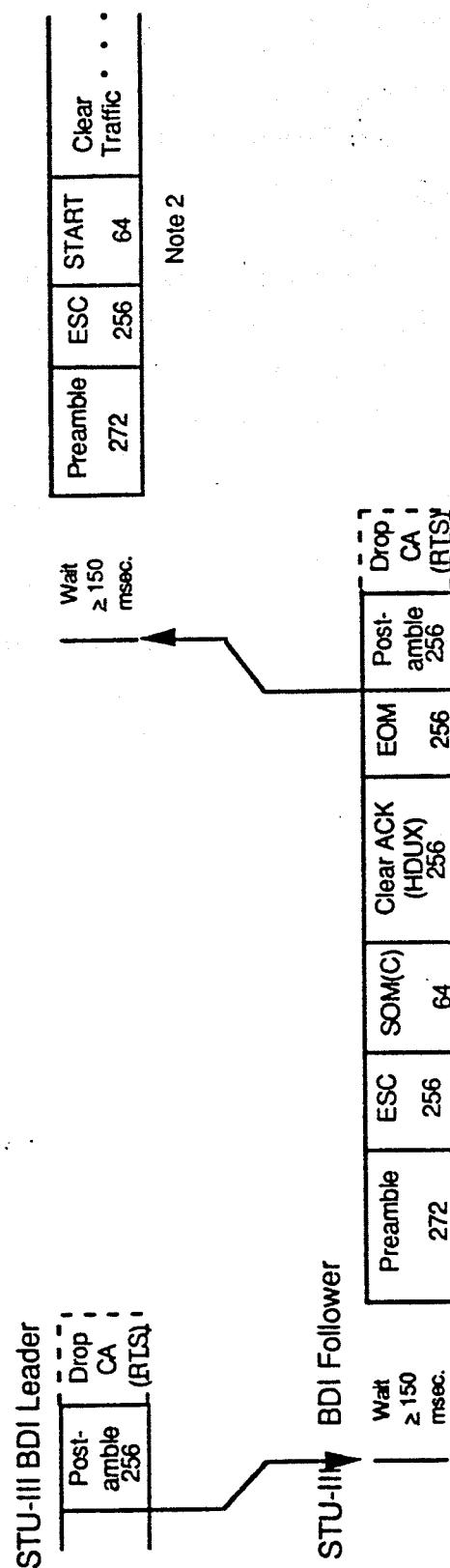


Figure 4.3.6.2.2.2.2-1 (b) Half-Duplex Failed Call Processing (Cont.)

SOM(C) prior to the Secure ACK message for the Responder terminal. Retrain messages shall only be transmitted once the terminals have exchanged initial Crypto Synchronization messages. The signaling protocols for secure call interruptions are specified in Section 4.3.6.2.1.3 for full-duplex operation, and in Section 4.3.6.2.2.3 for half-duplex operation. The signaling protocols for Retrains are specified in Section 4.3.6.2.1.2 for full-duplex operation, and in Section 4.3.6.2.2.2 for half-duplex operation.

Message	MID (Hex)
Abort	0800
Release	0700
Failed Call	8900
Restart Failed Call	A400
Retrain Request	1900
Retrain ACK	E500
Retrain NACK	1A00

Table 4.3.6.1.3-1 Secure Call Interruption Messages

4.3.6.2 STU-III BDI Secure Signaling

4.3.6.2.1 Full-Duplex Signaling

This section specifies the required secure call setup, rate transition and call interruption signaling for STU-III BDI terminals operating in the full-duplex mode. The following signaling scenarios are specified: Full-duplex secure call setup with no negotiated signaling rate change, full-duplex secure call setup with a negotiated signaling rate change, full-duplex mode to half-duplex mode transition and secure call setup, full-duplex retrain signaling rate change, and full-duplex secure call interruptions. Signaling requirements and associated transmission timelines for each of these scenarios are specified below.

4.3.6.2.1.1 Full-Duplex Secure Call Setup Signaling (MER)

The STU-III BDI shall perform secure call setup signaling as follows. The first terminal to initiate the secure call sequence (i.e, either the terminal whose secure control is activated, or the called terminal if the Auto-Secure strap is set) shall assume the role of the Initiator; the other terminal shall assume the role of the Responder. (Note that the secure Initiator and Responder do not necessarily correspond to the roles assigned during clear mode operation.)

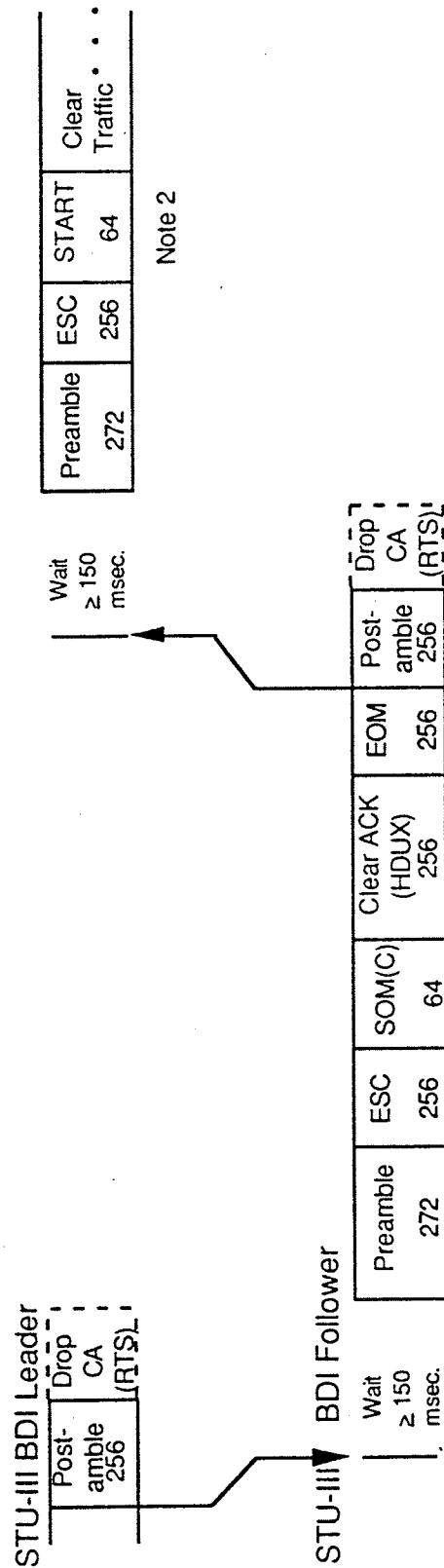
STU-III BDI Leader		STU-III BDI Follower	
Secure Traffic	EOM	EOM	Postamble
	256	256	256
Preamble	ESCAPE	SOM (C or A)	Failed Call
Note 1	272	256	256
Drop CA		EOM	Postamble
		256	256
Drop CA		CA	Drop CA
		(RTS)	(RTS)
Note 1			
Preamble	ESCAPE	SOM (C)	Go Clear (HDUX)
	272	256	256
Preamble	ESCAPE	SOM (C)	EOM
	272	256	256

Note 1: The Leader terminal must wait a minimum of 75 ms. and a maximum of 1.0 seconds after dropping the line before the clear initiation.

Figure 4.3.6.2.2.2.2-1 (a) Half-Duplex Failed Call Processing

Figure 4.3.6.2.1.1-1 illustrates the signaling for full-duplex secure call setup with no negotiated signaling rate change. In this case, both the secure signaling and secure traffic are transmitted at the digital network line rate. On secure initiation, the Initiator STU-III BDI shall transmit Preamble, followed by ESC, SOM(C), the Go Secure FDX message, EOM and Postamble, and then drop the line, i.e. turn off RTS. The Responder terminal, on detection of the EOM following the Go Secure FDX message, shall wait 150 msec. before transmitting Preamble, followed by ESC, SOM(C), the Secure ACK FDX message, and filler. (Note that filler is always transmitted in complete 64 bit frames.) The Initiator terminal, on detection of the Secure ACK FDX message, shall transmit Preamble, followed by ESC, SOM(C), Mode Msg A (offering the available voice/data rate(s)) and filler. The Responder terminal, on detection and processing of the Mode Msg A, shall transmit ESC, SOM(C), followed by Mode Msg B (selecting the voice/data rate equal to the line rate), at least the minimum filler, SOM(A) and the CAP/SV message. The Initiator terminal, on detection of the Mode Msg B, shall transmit at least the minimum filler, followed by SOM(C) and the CAP/SV message. The terminals shall then exchange the Terminal Cipher, Random Component Cipher and Crypto Sync messages, and enter the secure traffic mode, as specified in Reference 1.

Figure 4.3.6.2.1.1-2 illustrates the signaling for full-duplex secure call setup with a negotiated change in signaling rate. In this case, the secure mode control messages are transmitted at the line rate, while the variable exchange messages and secure traffic are transmitted at the "new" rate negotiated in the Mode Msg A/B exchange. Secure initiation and mode control signaling proceed precisely as specified previously for secure call setup with no negotiated signaling rate change. Upon transmission of the Mode Msg B selecting a new rate, the Responder terminal shall transmit filler at the new rate. (Note that filler is always transmitted in complete 64 bit frames.) The Initiator terminal, upon detection of Mode Msg B indicating a new rate, shall complete the frame of filler in process, and then shall transmit filler at the new BDI line rate, performing a circuit CH rate change. Otherwise, filler shall be transmitted word stuffed or error corrected, if a circuit CH rate change is not supported. (The minimum number of filler frames required is based on the traffic rate.) The Initiator terminal shall then transmit Preamble/ESC (only if a circuit CH rate change), followed by SOM(C) and the CAP/SV message (at the new BDI line rate, or word stuffed or error corrected). The Responder terminal, upon detection of Preamble (or SOM(C) if no circuit CH rate change), shall transmit Preamble/ESC (only if a circuit CH rate change), followed by SOM(A) and the CAP/SV message (at the new BDI line rate or word stuffed or error corrected). The terminals shall then exchange the Terminal Cipher, Random Component Cipher and Crypto Sync messages, and enter the secure traffic mode, as specified in Reference 1, all at the new BDI line rate or word stuffed or error corrected.



Note 2: The STU-III BDI starts signaling at the rate negotiated in the previous Y and Z message exchange.

Figure 4.3.6.2.2.2.1-1 (b) Half-Duplex Transition to the Nonsecure Mode (Cont.)

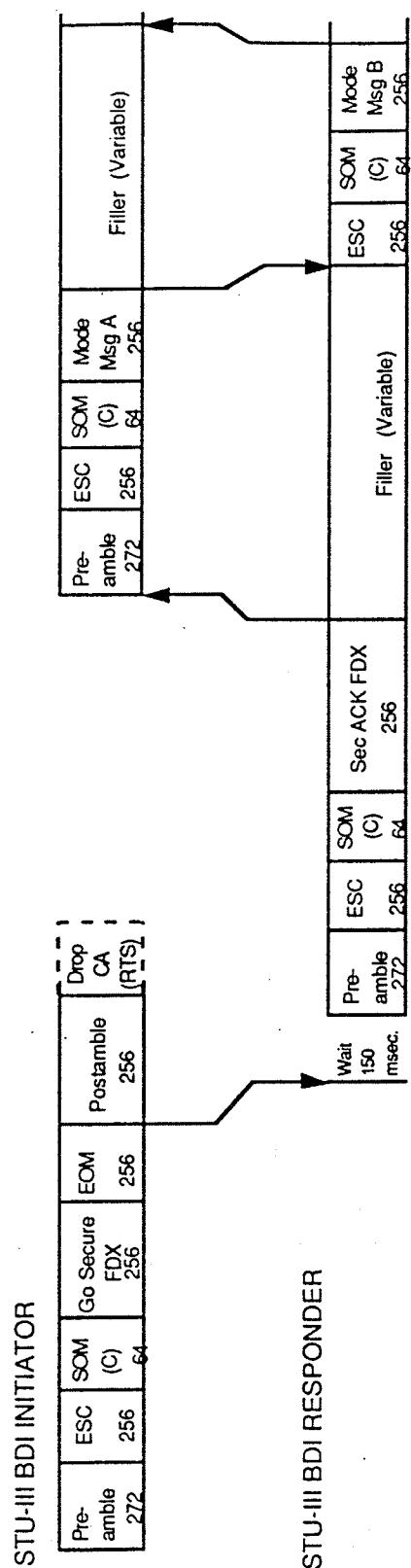
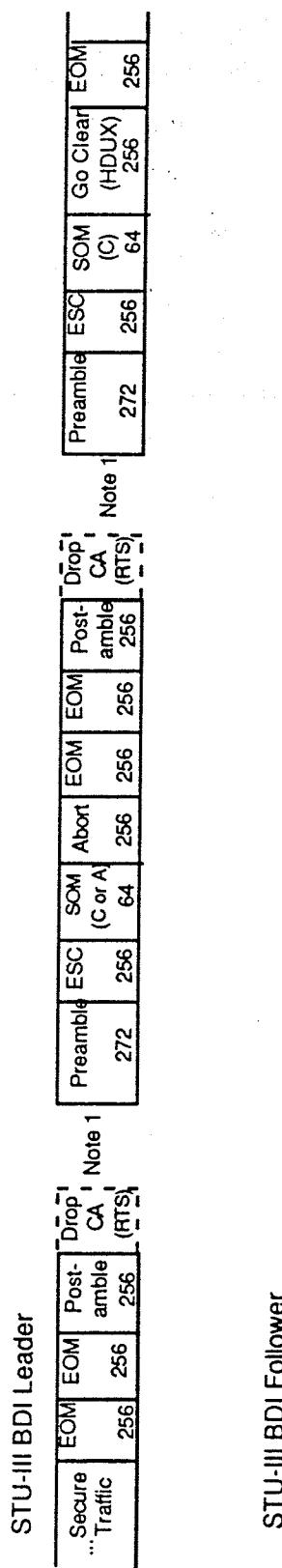
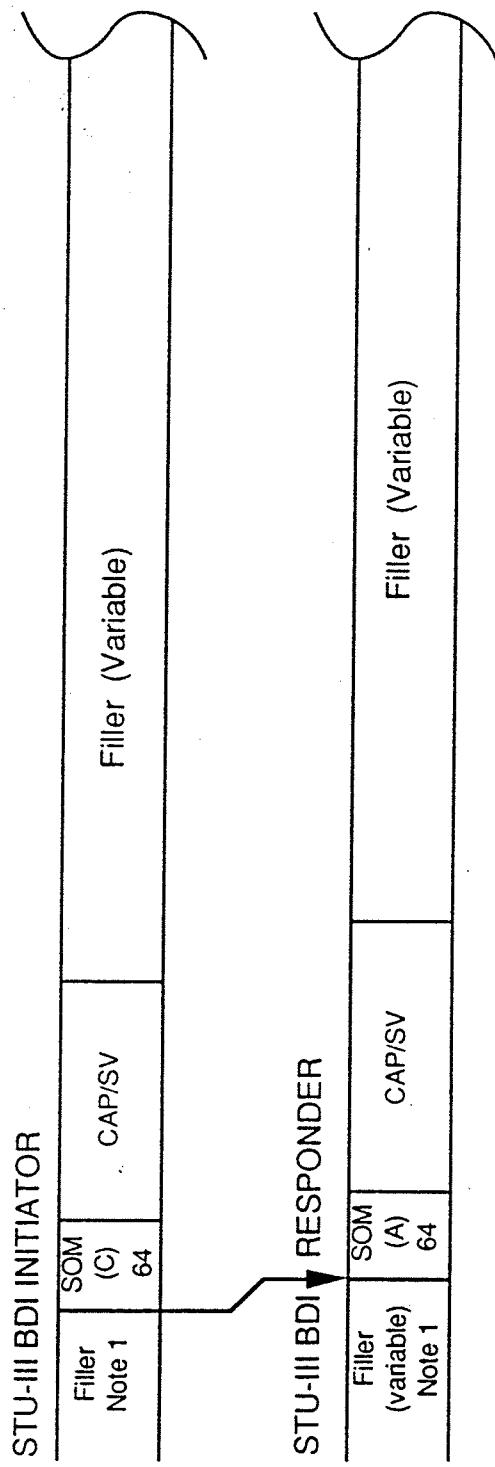


Figure 4.3.6.2.1.1-1 (a) Full-Duplex Secure Call Setup - No Negotiated Rate Change



Note 1: The Leader terminal must wait a minimum of 75 ms. and a maximum of 1.0 seconds after dropping the line before the clear initiation.

Figure 4.3.6.2.2.2.1-1 (a) Half-Duplex Transition to the Nonsecure Mode



Note 1: The following minimum filler shall be transmitted prior to any word stuffing or error correction:

- \geq 1472 bits at 2400 bps,
- \geq 2880 bits at 4800 bps,
- \geq 5760 bits at 9600 bps,
- \geq 8640 bits at 14400 bps,
- \geq 9600 bits at 16000 bps, and
- \geq 19200 bits at 32000 bps.

Filler shall always be transmitted in complete 64-bit frames.

Figure 4.3.6.2.1.1-1 (b) Full-Duplex Secure Call Setup - No Negotiated Rate Change (Cont.)

ms after detection of the Follower's EOM, shall transmit Preamble, ESC, and START, followed by nonsecure voice traffic all at the BDI line rate. The Follower terminal, upon detection of the Leader's EOM, shall wait at least 150 ms, before transmitting Preamble, ESC, and START, followed by nonsecure voice traffic.

If the nonsecure mode to be entered is less than the line rate, i.e., rate change is required, the Leader terminal shall, upon receipt of the Clear ACK (HDX) message, wait at least 150 ms after detection of the Follower's EOM, and then transmit the Preamble and ESC, at the BDI line rate, followed by START and nonsecure voice traffic at the new rate. The Follower terminal, shall wait at least 150 ms after detection of the Leader's EOM, then transmit Preamble and ESC, at the BDI line rate, followed by START and nonsecure voice traffic at the new rate.

Note: The Failed Call sequence sent by the Leader shall be transmitted at the current signaling/traffic rate, i.e., the Failed Call sequence (except for EOM/Postamble) shall be transmitted word stuffed or error corrected, if necessary. Clear mode control signaling (i.e., the Go Clear and Clear ACK sequences), however, shall be transmitted at the BDI line rate.

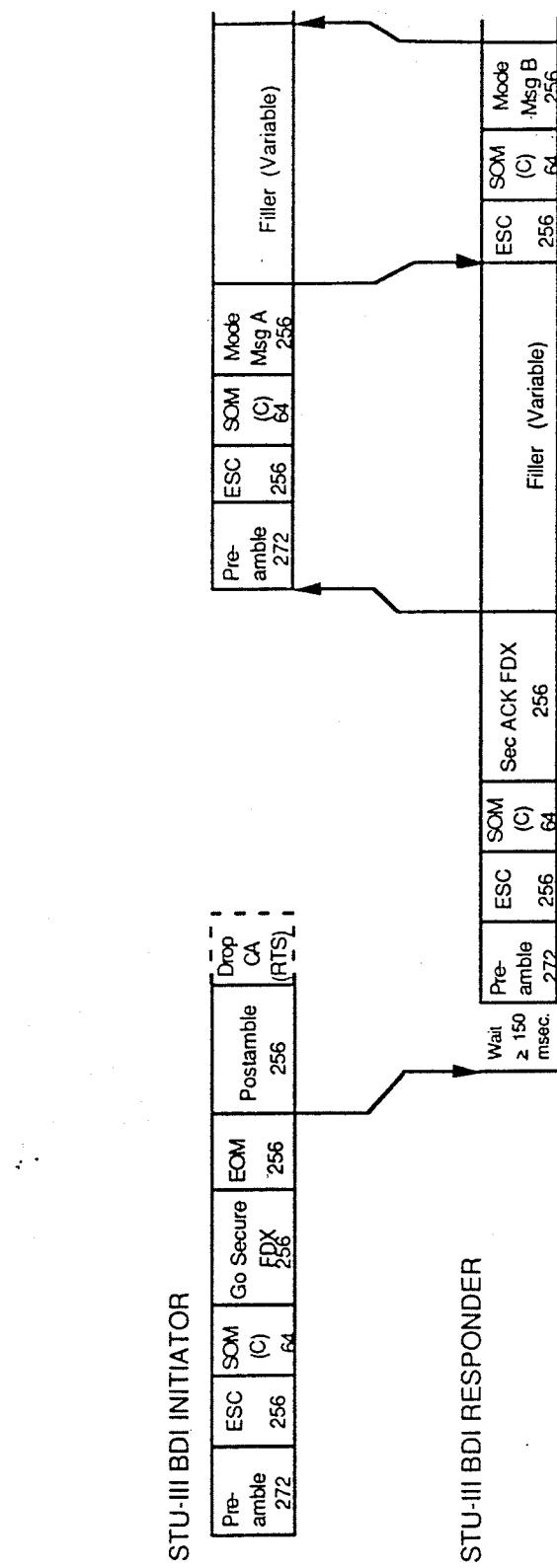


Figure 4.3.6.2.1.1-2 (a) Full-Duplex Secure Call Setup - With Negotiated Rate Change

new rate. Figure 4.3.6.2.2.1-1 illustrates the signaling timeline for transitions to the nonsecure mode.

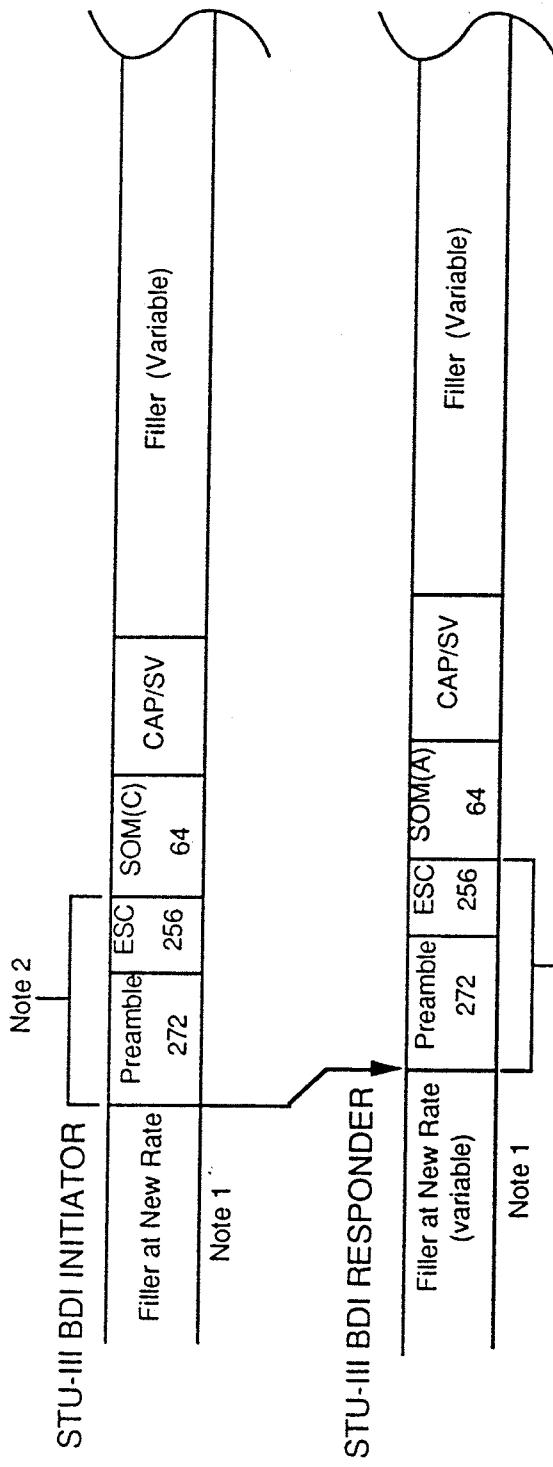
Note: The Abort sequence sent by the Leader shall be transmitted word-stuffed or error corrected. The EOM/Postamble sequence sent by the Follower shall be transmitted at the current line rate. Clear mode control signaling (i.e., the Go Clear and Clear ACK sequences) shall be transmitted at the line rate also.

4.3.6.2.2.2 Half-Duplex Failed Call Processing (MER)

Unless an alternative response is defined elsewhere in this document, the STU-III BDI terminal shall implement Failed Call signaling if it encounters a timeout, uncorrectable decryption error, or other invalid signaling condition that prohibits normal operation. The terminal detecting the failure shall assume the role of the Leader, transmit the appropriate signaling as specified below, and prompt the user to return to the nonsecure voice mode (if available) or to the clear idle mode (if nonsecure voice is not available). The Follower terminal, on detection of the failed call indication, shall prompt the user to return to the nonsecure voice mode. Each terminal shall connect its subscriber handset to the line only after the user has activated his nonsecure control.

The signaling timeline for Failed Call processing is illustrated in Figure 4.3.6.2.2.2-1. Upon detection of the failure, the Leader terminal shall wait at least 150 ms after detection of the far-end's EOM, then shall transmit Preamble, ESC, followed by SOM(C) or SOM(A), Failed Call, EOM, EOM, and Postamble, then drop the line and prompt the user to return to the nonsecure voice mode, i.e., press 'Clear' or the equivalent nonsecure control. The Follower terminal, upon detection of the Failed Call message, shall prompt its user to press 'Clear' or the equivalent nonsecure control. Once the user at the Leader terminal has been prompted to press Clear, the Leader shall wait between 75 and 1000 ms, then transmit Preamble followed by ESC, SOM(C), Go Clear (Half-Duplex) followed by EOM, Postamble, and then drop the line. Note: the Go Clear message shall only request a nonsecure mode, either full or half duplex, offered during the Y/Z exchange. After receipt of the Go Clear (Half-Duplex) message, and at least 150 ms after detection of the Leader's EOM, the Follower shall transmit Preamble, followed by ESC, SOM(C), Clear ACK (Half-Duplex), followed by EOM, Postamble, and then drop the line.

If the nonsecure voice mode to be entered is identical to the line rate, i.e., no rate change is required, the Leader terminal, upon receipt of the Clear ACK (HDX) message and at least 150



Note 1: This filler is transmitted at the new rate, if there is a circuit CH rate change. Otherwise it is transmitted word stuffed or error corrected. The number of filler bits given is prior to any word stuffing or error correction.

- ≥ 1472 total bits at 2400 bps,
- ≥ 2880 total bits at 4800 bps,
- ≥ 5760 total bits at 9600 bps,
- ≥ 8640 total bits at 14400 bps,
- ≥ 9600 total bits at 16000 bps, and
- ≥ 19200 total bits at 32000 bps.

Note 2: If a signaling rate change is required, and a circuit CH rate change is supported, these messages shall be transmitted at the new line rate and the previous filler is also sent at the new line rate. If a signaling rate change is required and circuit CH is not supported, then these messages are not sent, and the previous filler, shall be transmitted word stuffed or error corrected.

Figure 4.3.6.2.1.1-2 (b) Full-Duplex Secure Call Setup - With Negotiated Rate Change (Cont.)

4.3.6.2.2.2 Half-Duplex Call Interruption (MER)

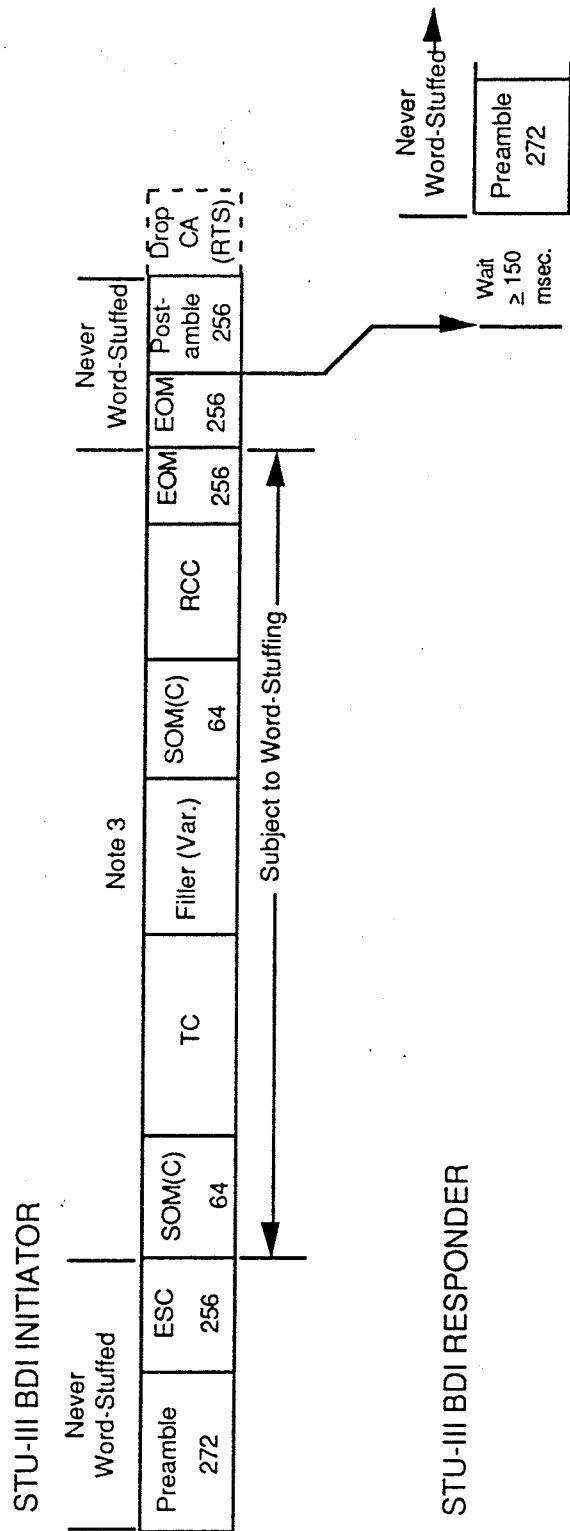
Half-duplex Call Interruption is processed similarly to the full-duplex mode. When the interruption occurs, the "Leader" terminal (terminal initiating the interruption) must wait until it is not receiving a transmission from the far-end (DCD is off). The Leader then transmits Preamble and an ESC pattern followed by the interruption message (e.g., Release, Abort, Failed Call). The far-end, "Follower" terminal, after detecting the interruption message, must wait at least 150 ms after detection of the Leader's second EOM. The Follower terminal shall then process the interruption message appropriately and send the proper response. Following the transmission of the response, the Leader terminal shall transmit the appropriate mode control or alerting message (e.g., Go Clear, etc.) indicating the operational state to be entered (e.g., nonsecure voice, on-hook etc.) following the interruption.

4.3.6.2.2.1 Half-Duplex Transition to the Nonsecure Mode (MER - OC)

If the user forces a transition back to the nonsecure mode of operation, i.e., presses the 'Clear' button or equivalent nonsecure control, that terminal, defined herein as the Leader, shall inform the far end of the intent to return to the nonsecure mode. The Leader terminal shall wait until it has the line (i.e., at least 150 ms. after detection of EOM from the far-end terminal) and then transmit Preamble, ESC, followed by SOM(C) or SOM(A), Abort, and EOM, EOM, Postamble, and then drop the line. Once EOM has been detected the Leader shall wait between 150 and 1000 ms, and shall then transmit Preamble, followed by ESC, SOM(C), Go Clear (Half-Duplex), followed by EOM, Postamble, and then drop the line. **Note:** The Go Clear message shall only request a nonsecure mode, either full or half duplex, offered during the Y/Z exchange. The Follower terminal, upon receipt of the Go Clear (Half-Duplex) message, shall prompt the user to press 'Clear' (or the appropriate nonsecure control). The terminal shall then transmit Preamble, followed by ESC, SOM(C), Clear ACK (Half-Duplex,) EOM, Postamble, and then drop the line. The terminal shall not transmit clear traffic until the user has pressed the non-secure button.

If the nonsecure mode to be entered is less than the line rate, i.e., rate change is required, the Leader terminal shall, upon receipt of the Clear ACK (HDX) message, transmit the Preamble, and ESC, at the BDI line rate, followed by START and nonsecure traffic at the new rate. The Follower terminal shall wait at least 150 ms after detection of the Leader's EOM and then shall transmit Preamble and ESC at the BDI line rate, followed by START and nonsecure traffic at the

Figure 4.3.6.2.1.1-3 illustrates the signaling for full-duplex to half-duplex mode transition. In this case, the Initiator terminal attempts secure signaling in full-duplex mode, but the Responder forces a transition to the half-duplex mode and becomes the half-duplex Initiator. On secure initiation, the Initiator STU-III BDI shall transmit Preamble, followed by ESC, SOM(C), the Go Secure FDX message, EOM and Postamble, and then drop the line, i.e. turn off RTS. The Responder terminal, on detection of the Go Secure FDX message and EOM, shall wait 150 ms before transmitting Preamble, followed by ESC, SOM(C), the Go Secure HDX message, filler (a minimum number of frames depending on rate), SOM(C), the CAP/SV message, EOM and EOM/Postamble, and then drop the line. The original full-duplex Initiator shall assume the role of the half-duplex Responder and transmit Preamble, followed by ESC, SOM(A), the CAP/SV message, filler, SOM(A), the Terminal Cipher message, EOM and EOM/Postamble, and then drop the line. Half-duplex secure call setup and entry into the half-duplex secure traffic mode proceeds as specified in Reference 1.



Note 3: Variable filler to allow preparation time for RCC.

Figure 4.3.6.2.2.1-1 (c) STU-III BDI to STU-III BDI Half-Duplex Signaling (Cont.)

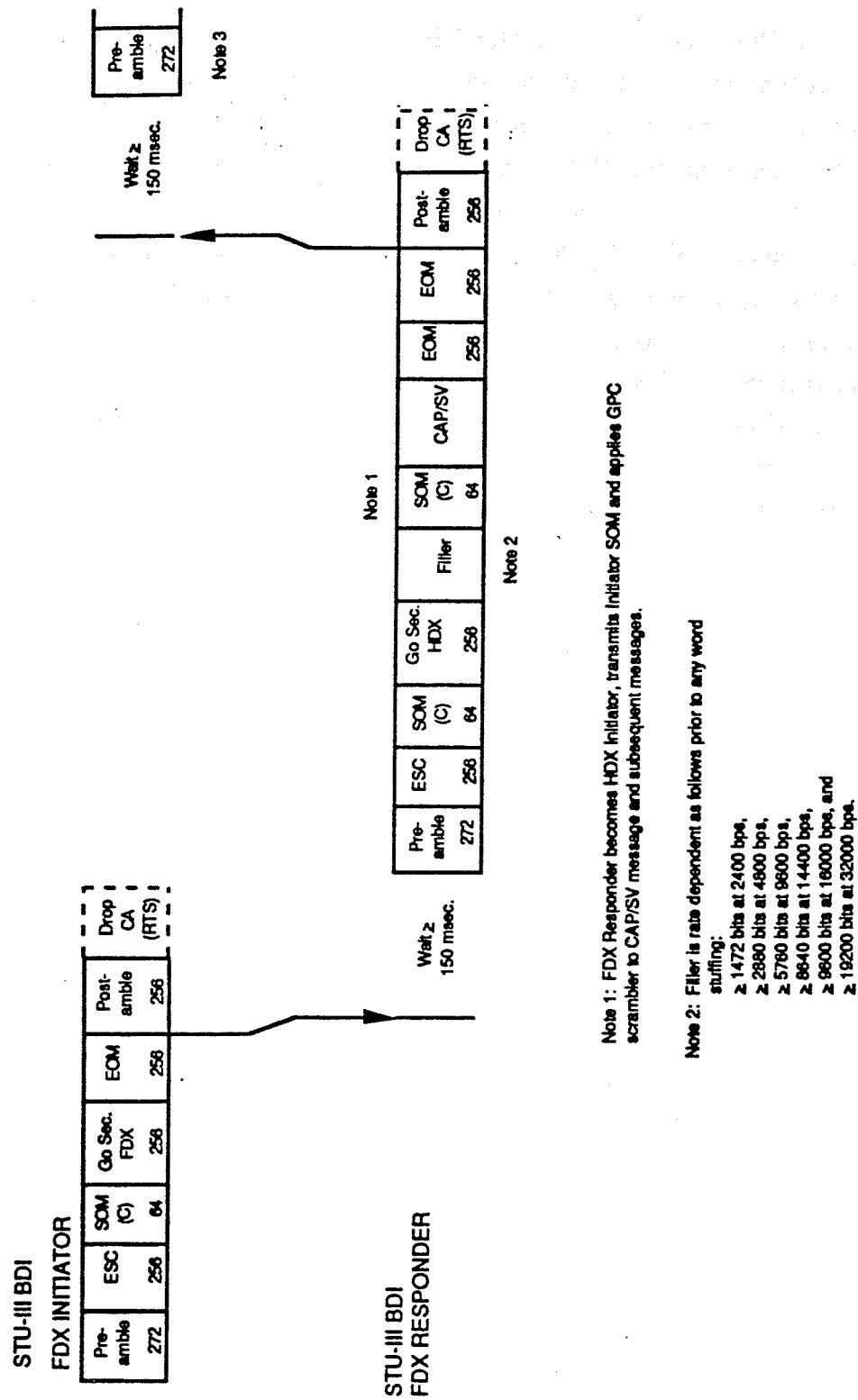
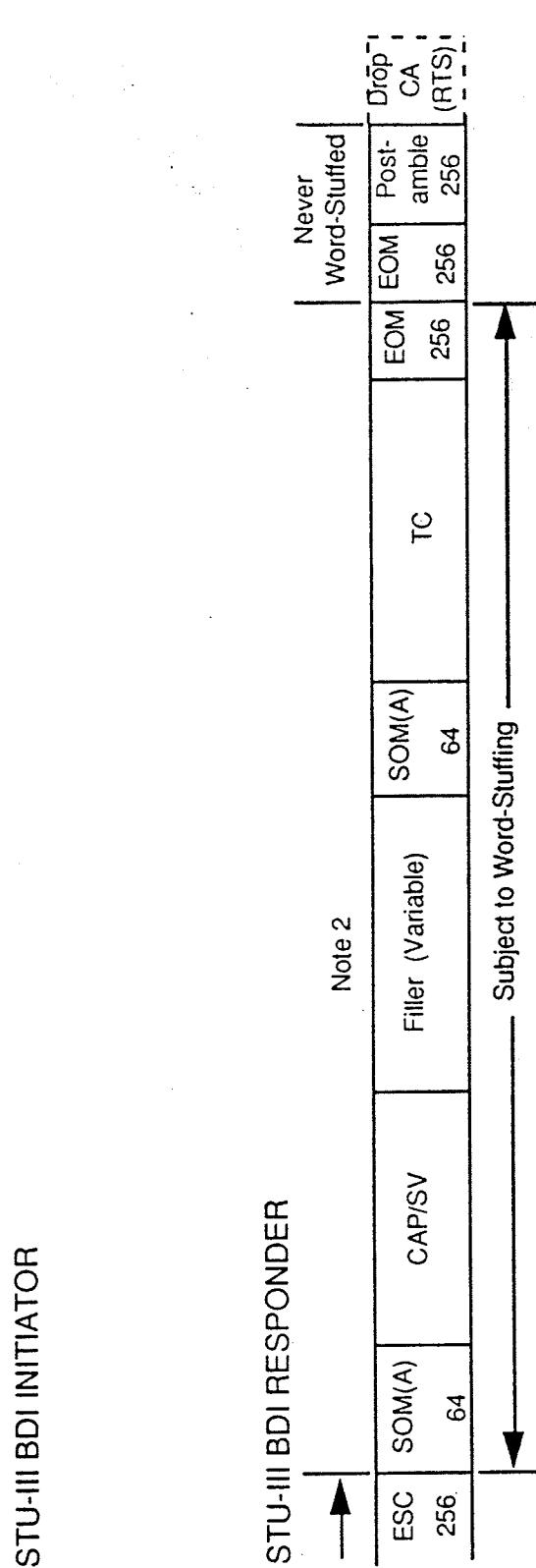


Figure 4.3.6.2.1.1-3 (a) Full-Duplex to Half-Duplex Mode Transition and Secure Setup



Note 2: Variable filler to allow time to process TC.

Figure 4.3.6.2.2.1-1 (b) STU-III BDI to STU-III BDI Half-Duplex Signaling (Cont.)

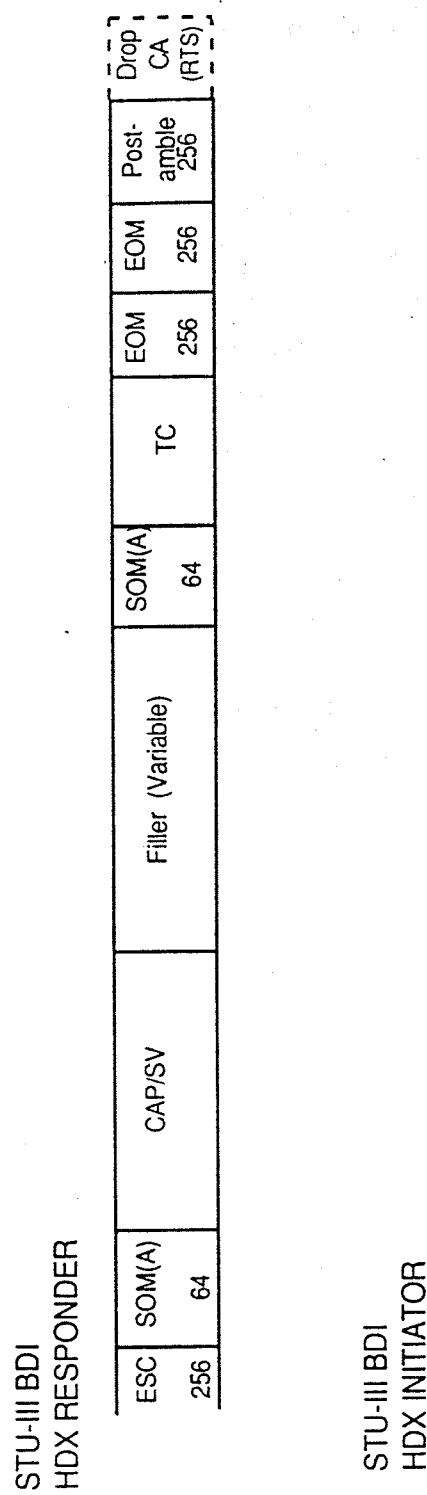


Figure 4.3.6.2.1.1-3 (b) Full-Duplex to Half-Duplex Mode Transition and Secure Setup (Cont.)

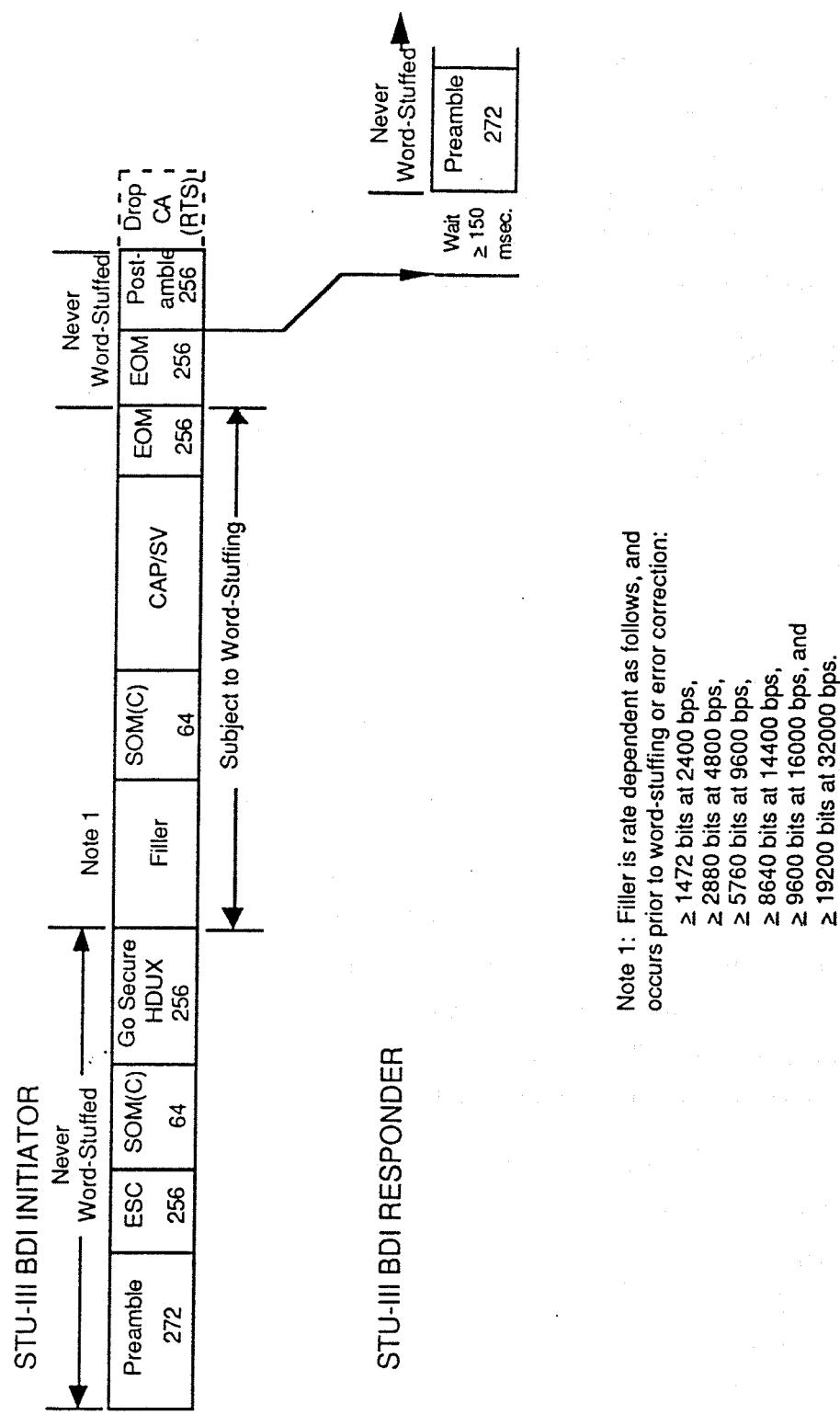


Figure 4.3.6.2.2.1-1 (a) STU-III BDI to STU-III BDI Half-Duplex Signaling

4.3.6.2.1.1.1 Full-Duplex Retransmission Protocol (MER)

The STU-III BDI terminal shall provide a full-duplex automatic ACK/NACK retransmission protocol. The ACK/NACK retransmission protocol is specified in FSVS-210 as optional for the analog STU-III. It is herein specified as a requirement for the STU-III BDI, and shall apply to both variable exchange and secure mode control messages. If a secure mode control or secure call setup message response is not received within the timeout specified, the STU-III BDI shall retry i.e., retransmit a message or message sequence, three times before failing the call. The ACK/NACK protocol shall be implemented as specified in paragraph 2.2.1.3.1 of FSVS-210 (Reference 1), with all references to analog messages either removed or replaced with appropriate digital equivalents.

The timeouts for the full-duplex ACK/NACK retransmission protocol are essentially the same as those for the analog STU-III given in Reference 1. Definitions of these timeouts are driven by the requirement to interoperate with analog STU-IIIIs through a digital/analog interworking function. Table 4.3.6.2.1.1.1-1 is an adaptation of FSVS-210 Table 2-2 with the analog messages and responses replaced by their digital equivalents.

Some users may operate under conditions where the propagation delay is greater than that of the assumed path with three satellite hops. The user-configurable Extended Timeout mode provides an additional six seconds for processing and propagation delays of an unusually long duration. The STU-III BDI terminal user shall be able to enable or disable this feature as required.

4.3.6.2.2 Half-Duplex Signaling

This section specifies the required secure call setup, rate transition and call interruption signaling for STU-III BDI terminals operating in the half-duplex mode. The following signaling scenarios are specified: half-duplex secure call setup with no negotiated signaling rate change, half-duplex secure call setup with a negotiated signaling rate change, half-duplex retrain signaling rate change, and half-duplex secure call interruptions. Signaling requirements and associated transmission timelines for each of these scenarios are specified below.

4.3.6.2.2.1 Half-Duplex Secure Call Setup Signaling (MER)

The signaling format for half-duplex secure call setup is shown in Figure 4.3.6.2.2.1-1. The Initiator transmits first, and shall transmit the Preamble, ESC, SOM(C), followed by the Go Secure Half-Duplex (Responder), filler, and CAP/SV messages in a single transmission. The transmission shall be terminated with an FSVS-210 End of Message followed by the FSVS-211 EOM/Postamble. The terminal shall then drop the line, i.e., drop RTS.

After detection of the Initiator's second EOM, the Responder shall wait at least 150 msec. and then shall transmit the Preamble, ESC and SOM(A), followed by the CAP/SV and TC messages in a single transmission. This transmission shall also be terminated with an (FSVS-210) EOM followed by an (FSVS-211) EOM/Postamble. The terminal shall then drop the line.

There is no minimum filler requirement for the half-duplex case defined above. However, to account for the case of a FDX Initiator being turned around to become a HDX Responder a minimum filler requirement of 600 msec. shall be sent after transmission of the Go Secure HDX message. A variable filler is defined following the Responder's CAP/SV message to allow time for preparing the TC for transmission. Similarly, a variable length filler after the Initiator's TC message allows time to prepare RCC.

After the Initiator's CAP/SV transmission is terminated, all subsequent transmissions, for both Initiator and Responder, are identical to those specified in FSVS-210 for analog STU-IIIs, (Figures 2-44, 2-46, and 2-48, Reference 1) except for the replacement of P1800 Hz, the 3202 dubits, and scrambled ones (SCR1) by the FSVS-211 Preamble and ESC at the beginning of messages, and the addition of an FSVS-211 EOM/Postamble at the ending of messages. Note that for half-duplex transmission, the STU-III BDI shall assert and negate RTS for each transmission.

The appropriate terminal, as indicated in column A, shall set a timer at selected points in the call setup as specified in column B. The timer duration is defined in column C. If the timeout is exceeded before the expected message in column D is detected, the terminal shall enter the signaling sequence in column E.

A	B	C	D	E
Terminal Setting Timer	Message Transmitted Starts Timer	Timer Value (Add 6 sec. for Extended mode)	Expected Response	Response to Timeout
Initiator	Final Bit of Post-amble following Go Secure FDX message	3.3 ± .7 sec.	Secure ACK FDX message	Retransmit Go Secure FDX sequence or Failed Call
Initiator (through IWF)	Final Bit of Post-amble following Go Secure FDX message	7.3 ± .7 sec.	IWF Status message	Retransmit Go Secure FDX sequence or Failed Call
Responder	Final bit of Secure ACK FDX	2.5 ± .6 sec	Mode Msg A	Retransmit Secure ACK FDX or Failed Call
Responder (through IWF)	Final bit of Secure ACK FDX	7.3 ± .7 sec	IWF Status message	Retransmit Secure ACK FDX or Failed Call
Initiator	Final Bit of Mode Message A	2.5 ± .6 sec.	Mode Message B	Retransmit Mode Msg A or Failed Call
Initiator	Final Bit of CAP/SV	2.5 ± .6 sec.	SOM(A) of CAP/SV	Retransmit CAP/SV or Failed Call, per Fig. 2-9 of FSVS-210
Either Terminal (through IWF)	Final Bit of CAP/SV	20 ± .6 sec.	SOM of CAP/SV	Retransmit CAP/SV or Failed Call, per Fig. 2-9 of FSVS-210
Either Terminal	Final Bit of TC	2.5 ± .6 sec.	SOM of TC	Retransmit TC or Failed Call, per Fig. 2-10 of FSVS-210
Either Terminal	Final Bit of RCC	5.8 ± .6 sec.	SOM of RCC	Retransmit RCC or Failed Call, per Fig. 2-12 of FSVS-210
Initiator	Final Bit of Initial CS	5.8 ± .6 sec.	SOM(A) of CS	Retransmit CS or Failed Call, per Fig. 2-20 of FSVS-210
Initiator	Final Bit of Retry of Initial CS	5.8 ± .6 sec.	SOM(A) of CS	Retransmit CS or Failed Call, per Fig. 2-20 of FSVS-210
Responder	Final Bit of RCC	10.0 ± .6 sec.	SOM(C) of CS	Failed Call per FSVS-210
Either Terminal (Optional Timeout for Secure Voice Mode Only)	Final Bit of Start	2.5 ± .6 sec.	Start	Initiate Crypto Resync or Failed Call per FSVS-210
Leader	Final Bit of CS Mode Change	2.5 ± .6 sec.	ESC Sequence (any)	Repeat CS Mode Change or Failed Call per FSVS-210
Either Terminal	Final Bit of Alerting or Miscellaneous Control Messages	3.3 ± .7 sec.	Alert ACK or equivalent	Retransmit Alert or Go On-Hook

Table 4.3.6.2.1.1.1-1 Timeouts for Retransmission Protocol

STU-III BDI Leader

STU-III BDI Follower					
ESC 256	SOM (C) 64	Ack 256	EOM 256	Postamble 256	Drop CA (RTS)

Figure 4.3.6.2.1.3.4-1 (b) Full-Duplex Release Processing (Cont.)

4.3.6.2.1.2 Full-Duplex Retrain Signaling (MER)

This section specifies the protocols for a retrain request and accompanying retrain signaling in the full-duplex mode. In a retrain, the STU-III BDI terminal transitions to a new signaling and secure traffic rate without repeating the entire exchange of secure call setup messages. The STU-III BDI shall not attempt to initiate a retrain until the terminal has transmitted its own initial Crypto Sync and has received the initial Crypto Sync from the remote terminal. Note: The Leader/Initiator terminal shall only attempt to retrain into one of the modes the Follower/Responder terminal has indicated as available in the CAP/SV message most recently transmitted.

Figure 4.3.6.2.1.2-1 illustrates the signaling for STU-III BDI full-duplex retrain signaling. The terminal requesting the retrain shall assume the role of the Leader and transmit ESC, followed by SOM(C) or SOM (A), depending on its Initiator/Responder status, the Retain Request message, and filler. The terminal detecting the Retain Request shall assume the role of the Follower and, if *not* capable of supporting the retrain, shall transmit ESC followed by SOM(A) or SOM (C), depending on its Initiator/Responder status, the Retain NACK message, and filler. The Leader terminal, upon detection of the Retain NACK message, shall initiate a cryptographic resynchronization as specified in Reference 1, Section 2.2.1.4. If the Follower terminal is capable of supporting the Retain, it shall, upon receipt of the Retain Request, transmit ESC, followed by EOM/Postamble, and then drop the line. The Leader terminal, upon detection of the EOM message, shall complete transmission of the filler frame in process, transmit EOM and Postamble, and then drop the line. The Leader terminal shall then wait between 150 ms and 1000 ms, and then initiate full-duplex secure call setup as specified in Section 4.3.6.2.1.1. The Mode Msg A transmitted by the Leader/Initiator shall indicate the new requested rate. The Mode Msg B transmitted by the Follower/Responder shall indicate acceptance of the new rate. Note: The Retain Request sequence and the Retain ACK/NACK sequence shall be transmitted at the current signaling/traffic rate, i.e., the Retain Request and Retain NACK sequences shall be transmitted word stuffed or error corrected if necessary. Initial secure call setup and mode control signaling however, shall be transmitted at the line rate.

If the new selected rate is identical to the line rate, i.e., no rate change required, the Responder terminal shall transmit ESC, SOM(C), and Mode Msg B accepting the new rate, followed by filler. The Initiator terminal, upon detection of Mode Msg B, shall transmit at least minimum filler, SOM(C), followed by the Crypto Sync message and filler. The Responder terminal, upon

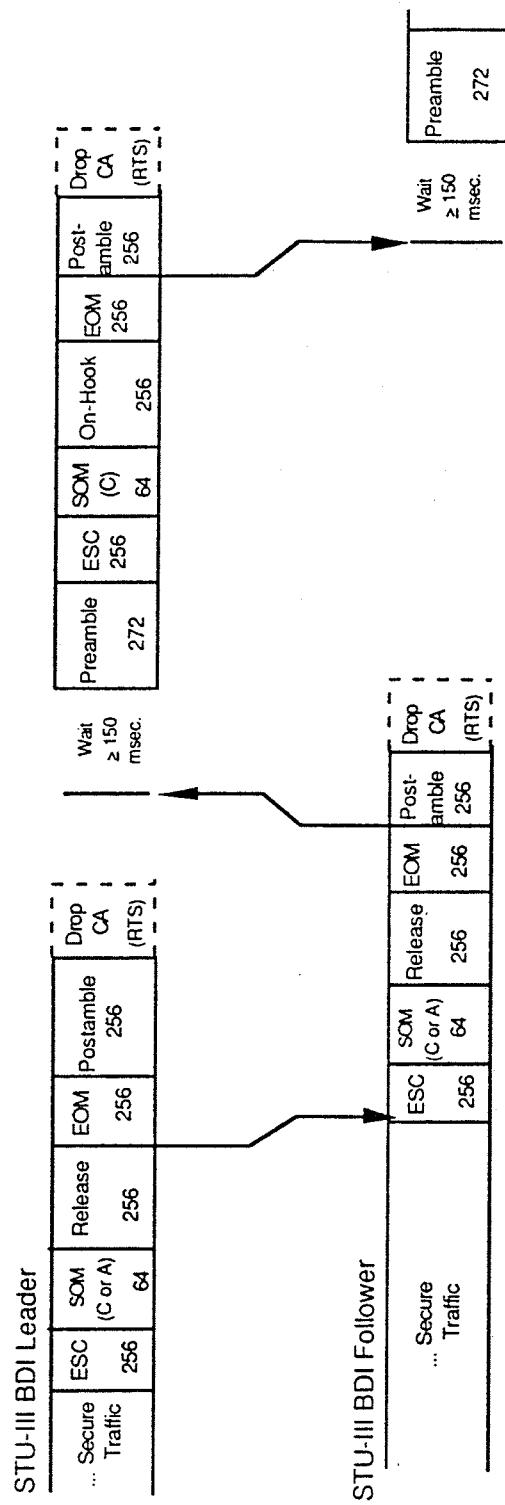
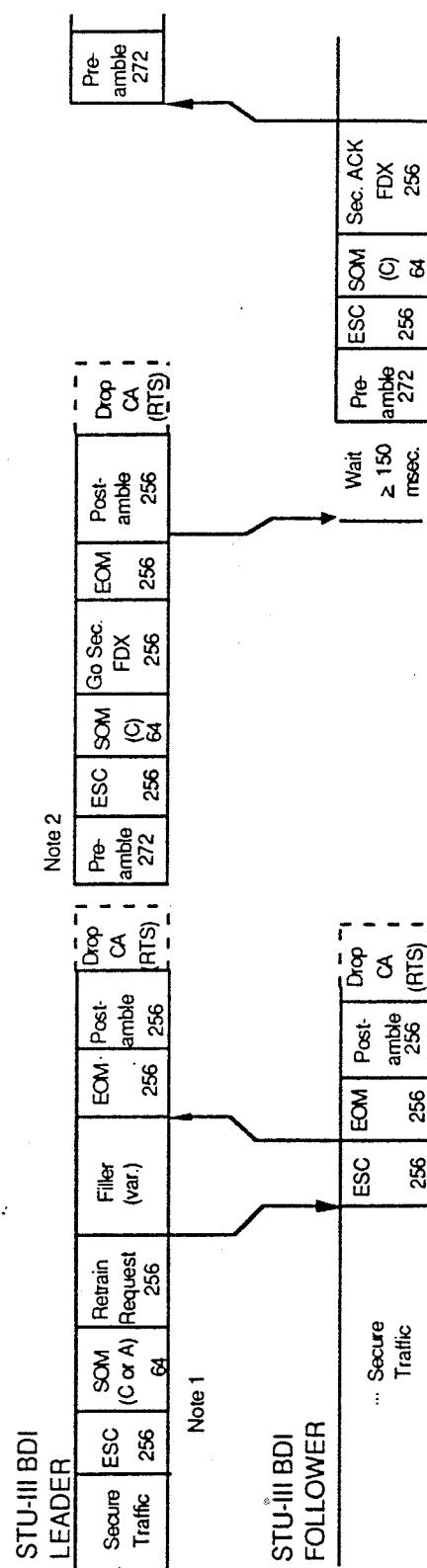


Figure 4.3.6.2.1.3.4-1 (a) Full-Duplex Release Processing



Note 1: Secure traffic, ESC, SOM(A) or SOM(C), Retrain Request, and filler are all subject to word stuffing. Preamble/ESC and EOM/Postamble are never word-stuffed.

Note 2: The Leader terminal must wait a minimum of 75 ms and a maximum of 1.0 seconds after detecting the Follower's EOM before initiating Retrain.

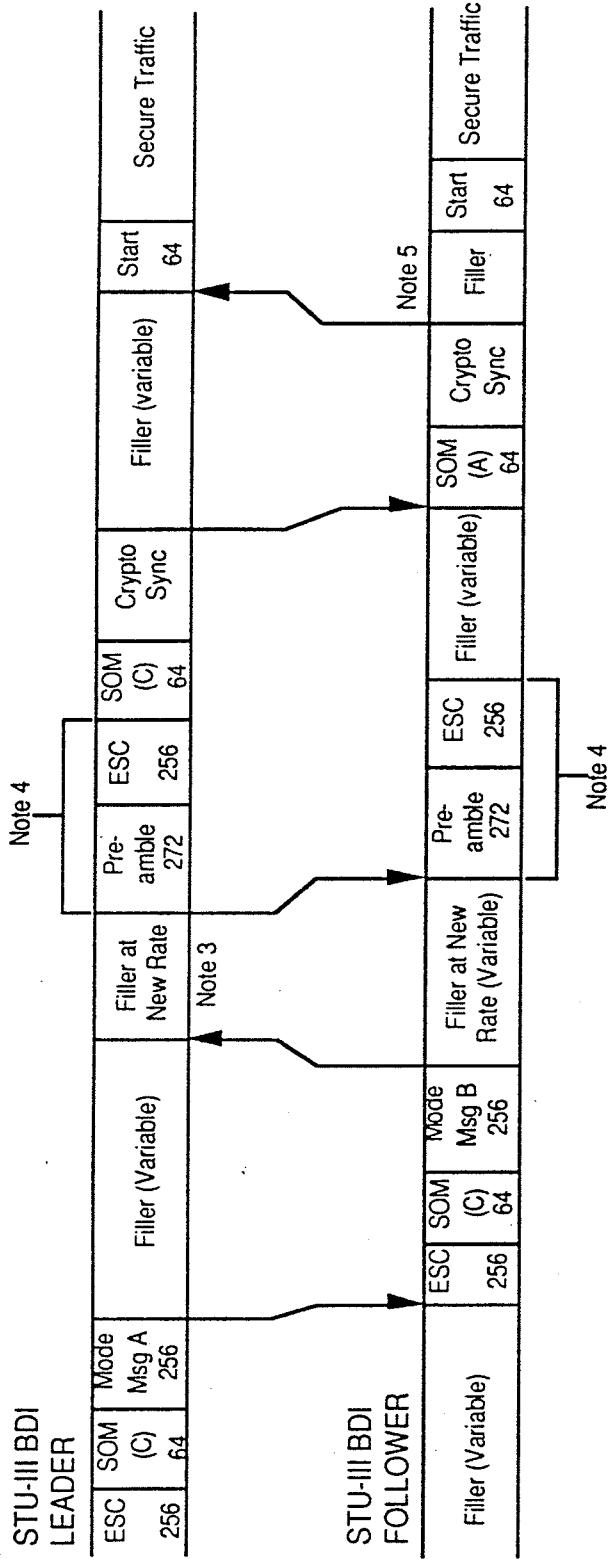
Figure 4.3.6.2.1.2-I (a) Full-Duplex Retrain Signaling

the Mode Msg A/B exchange, the STU-III BDI shall continue with the signaling procedures for a negotiated signaling rate change and secure call setup as specified in Section 4.3.6.2.1.1. **Note:** The Restart Failed Call sequence shall be transmitted at the current signaling rate, i.e., the Restart Failed Call sequence shall be transmitted word stuffed or error corrected. The subsequent initial secure call setup and mode control signaling, however, shall be transmitted at the BDI line rate.

If a glare condition exists and both terminals transmit the Restart Failed Call sequence, the restart shall proceed as specified above, with the original Initiator re-initiating the secure call setup. If, however, either terminal transmits the standard Failed Call message, this transmission shall take precedence over the request to restart and the rules for Failed Call processing shall apply.

4.3.6.2.1.3.4 Full-Duplex Release Processing (MER)

The STU-III BDI shall perform Release Processing when the user places the handset on hook or otherwise disconnects the call. The terminal placed on hook shall assume the role of the Leader and shall transmit ESC (per FSVS-210), followed by SOM(C) or SOM (A), Release and EOM/Postamble, and then drop the line. The Follower terminal, upon detection of the Release message and EOM, shall transmit ESC, followed by SOM(A) or SOM(C), Release, EOM/Postamble, then drop the line and prompt the user to go on hook. Once the Leader terminal has detected EOM, it shall wait 150 msec. and then transmit Preamble, followed by ESC, SOM(C), On-Hook, EOM and Postamble. It shall then drop the line and return to the on-hook Idle State. The Follower terminal, upon receipt of the On-Hook/EOM sequence, shall transmit Preamble, followed by ESC, SOM(C), Ack, EOM, and Postamble. It shall then drop the line and return to the on-hook Idle State and notify the user. Figure 4.3.6.2.1.3.4-1 illustrates the signaling timeline for full-duplex Release processing. Note: The Release sequences sent by the Leader and the Follower shall be transmitted at the current signaling rate, i.e., the Release sequences shall be transmitted word stuffed or error corrected. Alerting signaling (i.e., the On-Hook sequences), however, shall be transmitted at the line rate.



Note 3: This filler is transmitted at the new rate, if there is a circuit CH rate change. Otherwise it is transmitted word stuffed or error corrected. The number of filler bits given is prior to any word stuffing or error correction.

- ≥ 1472 total bits at 2400 bps,
- ≥ 2880 total bits at 4800 bps,
- ≥ 5760 total bits at 9600 bps,
- ≥ 8640 total bits at 14400 bps,
- ≥ 9600 total bits at 16000 bps, and
- ≥ 19200 total bits at 32000 bps.

Note 5: Filler is rate dependent as indicated. Number of bits is prior to any word stuffing or error correction.

- 256 bits (voice), ≥ 256 bits (data) at 2400 bps,
- 576 bits (voice), ≥ 576 bits (data) at 4800 bps,
- 1216 bits (voice), ≥ 1216 bits (data) at 9600 bps,
- 1536 bits (voice), ≥ 1536 bits (data) at 14400 bps,
- 1792 bits (voice), ≥ 1792 bits (data) at 16000 bps, and
- 3584 bits (voice), ≥ 3584 bits (data) at 32000 bps.

Note 4: If a signaling rate change is required, and a circuit CH rate change is supported, these messages shall be transmitted at the new line rate and the previous filler is also sent at the new line rate. If a signaling rate change is required and circuit CH is not supported, then these messages shall not be sent, and the previous filler shall be transmitted word stuffed or error corrected.

Figure 4.3.6.2.1.2-1 (b) Full-Duplex Retrain Signaling (Cont.)

If the nonsecure mode to be entered is less than the line rate, i.e., rate change is required, the Follower terminal, upon transmission of the Clear ACK (FDX) message, shall transmit filler at the new rate and/or word stuffed or error correction as required. The Leader terminal shall, upon receipt of the Clear ACK (FDX) message, complete transmission of the filler frame in process, and then transmit four or more frames of filler at the new rate and/or word stuffed as required, followed by Preamble, ESC (only if a circuit CH rate change), and START, followed by nonsecure voice traffic (at the new rate). The Follower terminal, upon receipt of Preamble from the Leader, shall transmit Preamble, ESC (only if a circuit CH rate change), and START, followed by nonsecure voice traffic (at the new rate). Note: The STU-III BDI terminal shall not activate the handset until the user has pressed clear.

Note: The Failed Call sequence sent by the Leader shall be transmitted at the current signaling rate, i.e., the Failed Call sequence shall be transmitted word stuffed or error corrected. Clear mode control signaling (i.e., the Go Clear and Clear ACK sequences), however, shall be transmitted at the line rate.

4.3.6.2.1.3.3 Full-Duplex Restart Failed Call Processing (MER)

As an alternative to the standard required Failed Call processing described above, the STU-III BDI may provide the capability to request a restart of the secure call setup for the purpose of negotiating 2400 bps operation. Note: The STU-III BDI must provide the capability to respond to a restart request as specified below; this is required for interoperation with an analog STU-III via an IWF. This automatic restart shall only be employed when the secure call setup fails due to transmission line quality. The standard Failed Call sequence shall always be used when the failure is due to incompatible key or other conditions not related to the quality of the transmission medium.

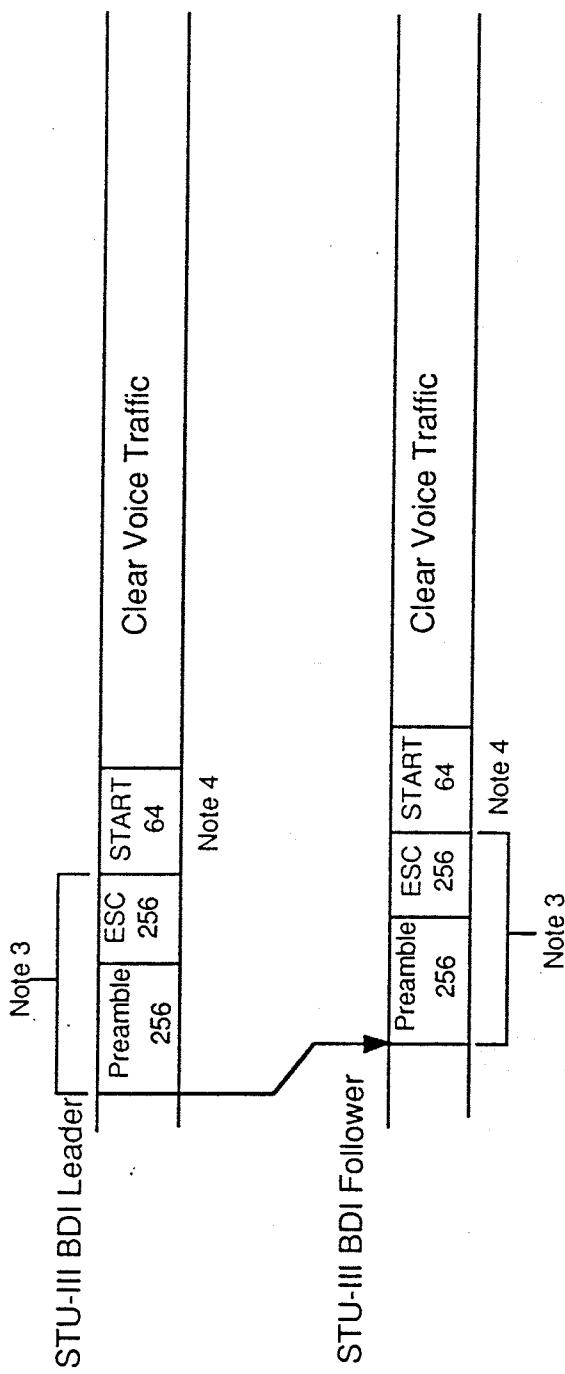
A STU-III BDI terminal detecting a failure and implementing the restart option shall assume the role of the Leader and transmit the FSVS-210 ESC pattern, followed by SOM(C) if the initiator or SOM (A) if responder, the Restart Failed Call message and EOM/Postamble, and then drop the line. The terminal detecting the Restart Failed Call message shall assume the role of the Follower and transmit EOM, followed by Postamble, and then drop the line. When the line is idle, the Initiator in the secure call setup attempt that failed shall re-initiate secure call setup by transmitting the Go Secure FDX sequence. Both terminals shall continue by following the standard secure call setup signaling as specified in Section 4.3.6.2.1.1. The Mode Msg A and Mode Msg B transmitted by the STU-III BDI terminal shall indicate 2400 bps operation. After

detection of the Initiator's Crypto Sync message, shall transmit SOM(A), followed by the Crypto Sync message, filler (a minimum number of frames based on the rate), and START, and then shall enter the new secure traffic mode. The Initiator terminal, upon detection of the Follower's Crypto Sync message, shall transmit START, and enter the new secure traffic mode.

If the new selected rate is less than the line rate, i.e., rate change is required, the Follower/Responder terminal, upon transmission of the Mode Msg B selecting the new rate, shall transmit filler at the new rate and/or word stuffed as required. The Leader/Initiator terminal, upon detection of Mode Msg B accepting the new rate, shall complete the frame of filler in process at the line rate, and then shall transmit filler at the new rate and/or word stuffed or error corrected as required. (The minimum number of filler frames required is based on the current signaling/traffic rate.) The Initiator terminal shall then transmit Preamble and ESC (only if a circuit CH rate change) at the line rate, followed by SOM(C), the Crypto Sync message, and filler at the new rate (or word stuffed or error corrected otherwise). The Responder terminal, upon receipt of the fixed length filler, shall transmit Preamble/ESC (only if a circuit CH rate change) at the line rate, followed by filler (at the new rate or word stuffed or error corrected). Upon detection of the Initiator's Crypto Sync message, the Responder shall transmit SOM(A), the Crypto Sync message, filler (a minimum number of frames based on the rate) and START, and then enter the secure traffic mode (all at the new rate). The Initiator terminal, upon detection of the Responder's Crypto Sync message, shall transmit START and enter the new secure traffic mode.

4.3.6.2.1.3 Full-Duplex Call Interruption Signaling (MER)

This section specifies the signaling for secure call interruptions in the full-duplex mode. When interruptions occur, the "Leader" terminal (terminal initiating the interruption) transmits an Escape (ESC) pattern followed by a message sequence indicating the particular situation (e.g., Release, Abort, etc.). The far-end, "Follower" terminal will detect the message, interrupt secure call setup or traffic, and process the interruption appropriately. Following the transmission of the call interruption message, the leader terminal shall transmit the appropriate mode control or alerting message (e.g., Go Clear, etc.) indicating the operational state to be entered (e.g., nonsecure voice) following the interruption.



Note 3: If no (CH) rate change or word stuffing or error correction is required, i.e., the traffic/signaling rate is identical to the current line rate, messages in brackets shall not be transmitted and the previous filler is sent at the current line rate. If a circuit CH rate change is required, these messages shall be transmitted at the new line rate and the previous filler sent at the new rate. If a signaling rate change is required and circuit CH is not supported, these messages are not sent and the previous filler shall be transmitted word stuffed or error corrected. The clear initiator transmits START followed by nonsecure traffic at the line rate. The clear responder shall transmit filler until detection of START and then transmit START followed by nonsecure traffic.

Note 4: The terminal shall not enable the handset until the user has activated the nonsecure control.

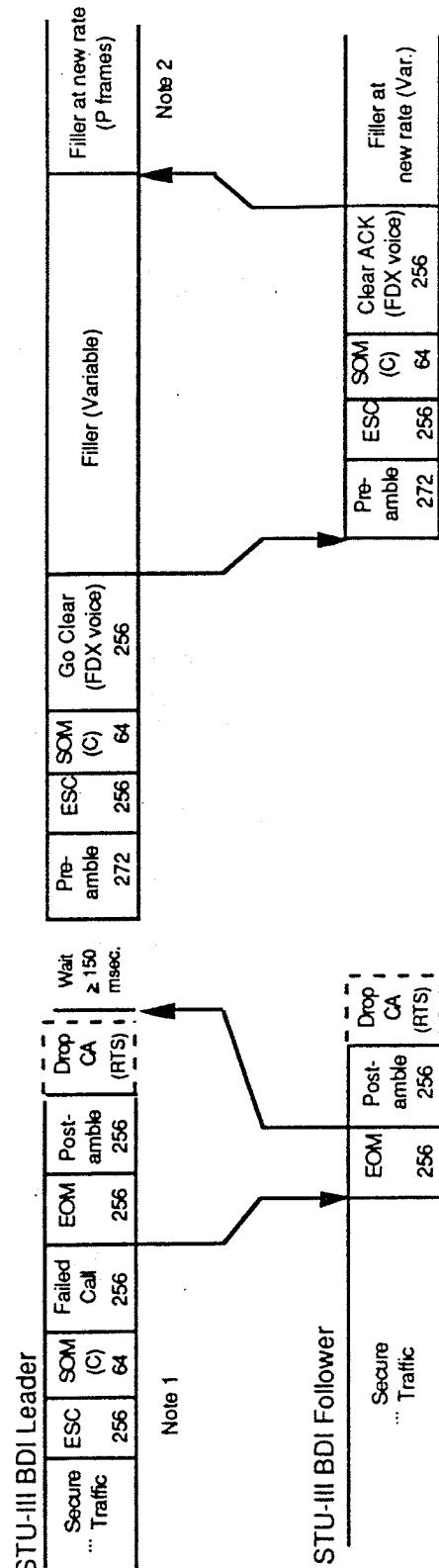
Figure 4.3.6.2.1.3.2-1 (b) Full-Duplex Failed Call Processing (Cont.)

4.3.6.2.1.3.1 Full-Duplex Transition to the Nonsecure Mode (MER - OC)

If the user forces a transition back to the nonsecure mode of operation, i.e., presses the 'Clear' button or equivalent nonsecure control, that terminal, defined herein as the Leader, shall inform the far end of the intent to return to the nonsecure mode. The Leader terminal shall transmit ESC followed by SOM(C) or SOM(A), depending on its Initiator/Responder status, Abort and EOM/Postamble, and then drop the line. The Follower terminal, upon detection of the Abort message, shall transmit EOM followed by Postamble, then drop the line. Once the Follower's EOM has been detected, the Leader shall wait between 150 and 1000 ms, and shall then transmit Preamble, followed by ESC, SOM(C), Go Clear (FDX), and filler. Note: The Go Clear message shall only request a nonsecure mode offered during the Message Y/Z exchange. If either terminal does not implement clear mode operation, the terminals shall default to the Clear Idle State (Idle State #2) automatically, by exchanging the Go Clear (Idle) and the Clear Ack (Idle) messages. For a given nonsecure mode, i.e., voice or data, the terminals shall select the highest common precedence level (for voice) or the highest common rate (for data) available. The Follower terminal, upon receipt of the Go Clear (FDX) message, shall prompt the user to press 'Clear' (or the appropriate nonsecure control) and shall transmit Preamble, followed by ESC, SOM(C), Clear ACK (FDX), and filler. Note: The Follower terminal shall not enable the handset or transmit nonsecure data until the user has activated the nonsecure control.

If the rate of the nonsecure mode to be entered is identical to the line rate, i.e., no rate change is required, the Leader terminal shall, upon receipt of the Clear ACK (FDX) message, transmit Start (or SOM(A)), followed by nonsecure traffic. The Follower terminal, upon detection of the Leader's SOM, shall transmit START followed by nonsecure traffic.

If the rate of the nonsecure mode to be entered is less than the current BDI line rate, and a circuit CH rate change is supported, the Follower terminal, upon transmission of the Clear ACK (FDX) message, shall transmit filler at the new rate as required. The Leader terminal shall, upon receipt of the Clear ACK (FDX) message, complete the transmission of the filler frame in process, and then transmit four or more additional frames of filler at the new rate as required, followed by Preamble, ESC, and START (or SOM(A)), followed by nonsecure traffic (at the new rate). The Follower terminal, upon receipt of Preamble, shall transmit Preamble, ESC, and START (or SOM(A)), followed by nonsecure traffic (at the new rate). Figure 4.3.6.2.1.3.1-1 illustrates the signaling timeline for transitions to the nonsecure mode.



Note 1: Secure traffic, ESC, SOM(A) or SOM(C), and Failed Call are all subject to word-stuffing. Preamble/ESC and EOM/Postamble are never word-stuffed.

Note 2: P = 4, 9, 19, 24, 28, or 56 frames for the signaling rates of 2400, 4800, 9600, 14400, 16000, or 32000 bps respectively.

Figure 4.3.6.2.1.3.2-1 (a) Full-Duplex Failed Call Processing

If a circuit CH rate change is not supported, then only a signaling rate change occurs, requiring rate adaption. The follower terminal upon transmission of the Clear ACK (FDX) message, shall transmit filler word stuffed or error corrected as required. The Leader terminal shall, upon receipt of the Clear ACK (FDX) message, complete the transmission of the filler frame in process, and then transmit four or more additional frames of filler word stuffed or error corrected as required, followed by START and nonsecure traffic (also word stuffed or error corrected). The Follower terminal, upon receipt of START, shall transmit START, followed by nonsecure traffic (all word stuffed or error corrected). Figure 4.3.6.2.1.3.1-1 illustrates the signaling timeline for transitions to the nonsecure mode.

Note: The Abort sequence sent by the Leader shall be transmitted at the current signaling rate, i.e., the Abort shall be transmitted word stuffed or error corrected. Clear mode control signaling (i.e., the Go Clear and Clear ACK sequences) shall be transmitted at the BDI line rate.

4.3.6.2.1.3.2 Full-Duplex Failed Call Processing (MER)

Unless an alternative response is specified elsewhere in this document, the STU-III BDI shall implement Failed Call signaling if it encounters a timeout, uncorrectable decryption error, or other invalid signaling condition that prohibits normal operation. The terminal detecting the failure shall assume the role of the Leader, transmit the appropriate signaling as specified below, and prompt the user to return to the nonsecure voice mode. The Follower terminal, on detection of the failed call indication, shall prompt the user to return to the nonsecure voice mode. Each terminal shall only connect its subscriber handset to the line after the user has activated his nonsecure control. **Note:** If either terminal does not implement clear mode operation, the terminals shall default to Clear Idle State on detection of a failure. As an alternative, the terminal may attempt to restart the call, as described in Section 4.3.6.2.1.3.3.

The signaling timeline for Failed Call processing is illustrated in Figure 4.3.6.2.1.3.2-1. Upon detection of the failure, the Leader terminal shall transmit ESC, followed by SOM(C) or SOM (A), Failed Call, and EOM/Postamble, then drop the line and prompt the user to return to the nonsecure voice mode, i.e., press 'Clear' or the equivalent nonsecure control. The Follower terminal, upon detection of the Failed Call message, shall transmit EOM followed by Postamble, then drop the line and prompt its user to press 'Clear' or the equivalent nonsecure control. The Leader shall then transmit Preamble, followed by ESC, SOM(C), Go Clear (FDX), and filler. Upon receipt of the Go Clear (Voice) message, the Follower shall transmit Preamble, followed by ESC, SOM(C), Clear ACK (FDX), and filler. **Note:** If either terminal does not support a common clear voice or data mode, then the terminals shall enter the Clear Idle State (Idle State #2) automatically, by exchanging the Go Clear (Idle) and the Clear Ack (Idle) messages.

If the nonsecure voice mode to be entered is identical to the line rate, i.e., no rate change is required, the Leader terminal shall, upon receipt of the Clear ACK (FDX) message, transmit START, followed by nonsecure voice traffic. The Follower terminal, upon detection of the Leader's START, shall transmit START followed by nonsecure voice traffic. **Note:** The STU-III BDI terminal shall not activate the handset until the user has pressed clear.

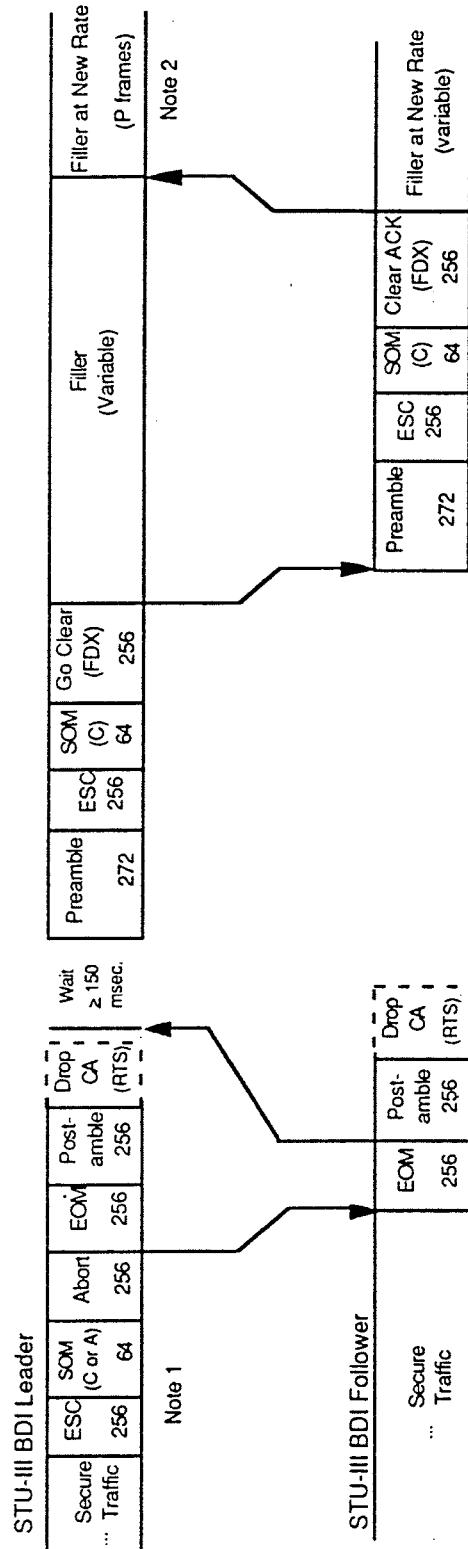
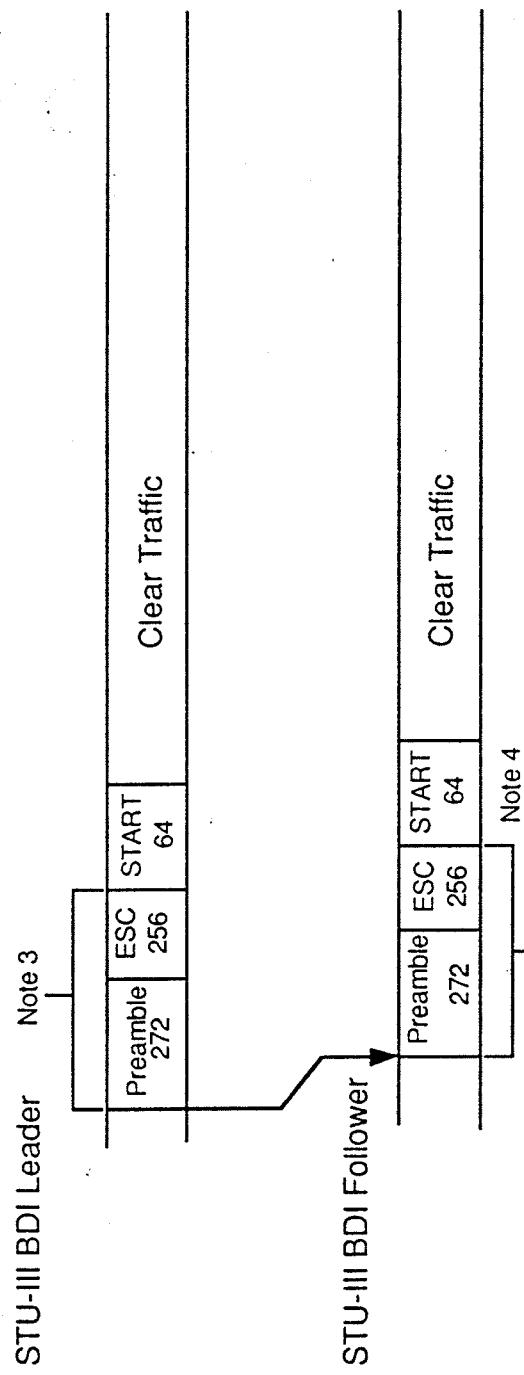


Figure 4.3.6.2.1.3.1-1 (a) Full-Duplex Transition to the Nonsecure Mode



Note 3: If no circuit CH rate change or word stuffing is required, i.e. the traffic rate is identical to the current line rate, messages in brackets shall not be transmitted and the previous filler is sent at the current line rate. If a circuit CH rate change is supported, these messages shall be transmitted at the new line rate and the previous filler shall be sent at the new rate. If a signaling rate change is required and circuit CH is not supported, the messages in brackets shall not be transmitted, and the previous filler is sent at the new rate. Preamble and Escape are never word-stuffed or error corrected.

Note 4: The Follower terminal shall not enable the handset or transmit nonsecure data until the user has activated the nonsecure control.

Figure 4.3.6.2.1.3.1-1 (b) Full-Duplex Transition to the Nonsecure Mode (Cont.)